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A MATHEMATICAL MODEL OF ELECTROSTATIC PRECIPITATION (REVISION 3): VOLUME II

User's Manual

by

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ABSTRACT

The objectives of this manuscript are to provide a comprehensive description of how to use the computer program which performs the calculations in the mathematical model of electrostatic precipitation and to instruct in the proper usage of the model. The input and output data associated with the computer program are described in detail and are presented in various forms covering the different uses of the model. Comparisons of the predictions of the model with experimental data are presented and the agreement obtained is discussed. The various applications of the model are described and demonstrated in detail. Applications of the model for troubleshooting and sizing of precipitators are discussed. Precautions to take in using the model are emphasized throughout the text.

CONTENTS

Abstract.... iii
Figures.... vii
Tables.... ix
Acknowledgments.... x
Metric Conversion Factors.... x

1. Introduction.... 1
2. Conclusions and Recommendations.... 2
3. Precautions to Take in Using the Model.... 4
4. Use of the Model for Sizing of Precipitators.... 11
5. Description of Input Data.... 16
    - General description.... 16
    - Construction of the basic data set.... 16
    - Construction of shortened data sets.... 40
    - Dynamic rapping data set.... 42
    - Opacity data set.... 44
    - Unknown operating conditions.... 45
6. Guide to the Use of Options.... 49
7. Description of Output Data.... 54
    - General description.... 54
    - Printout of input data.... 54
    - Incremental analysis of precipitator performance.... 55
    - Charging rates for the different particle sizes.... 57
    - Charge accumulated on the different particle sizes. 58
    - Particle size range statistics.... 58
    - Unadjusted migration velocities and discrete outlet mass loadings.... 61
    - Visible emission parameters.... 62
    - Summary table of precipitator operating parameters and performance.... 63
    - Precipitator output statistics for each rapping puff.... 63
8. Machine-Dependent Factors of the Computer Program.... 65
9. Example Cases and Comparisons Between Model Predictions and Experimental Measurements.... 68
    - Comparisons of model predictions with laboratory data.... 68
    - Comparisons of model predictions with field data... 76
    - Example of model predictions using dynamic rapping.... 80
    - Example of model predictions using the internal data set.... 85

10. Applications of the Model 88
    Effect of particle size distribution 88
    Effect of specific collection area 89
    Effect of applied voltage and current density 92
    Effect of nonideal conditions 99
    Effect of resistivity 105
    Use of the estimation procedure 106
11. Use of the Model for Troubleshooting 111

References 117

Appendices

A. Output Data from Example 1 119
B. Output Data from Example 2 134
C. Output Data from Example 3 150
D. Output Data from Example 4 169
E. Output Data from Example 5 187
F. Output Data from Example 6 195
G. Output Data from Example 7 223
H. Output Data from Example 8 258
I. Output Data from Example 9 286
J. Output Data from Example 10 314
K. Output Data from Example 12 344

FIGURES

Number		Page
1	Experimentally determined effect of resistivity on allowable current density in a precipitator.........	6
2	Flow chart for the input data logic.................	17-20
3	Comparison of experimental fractional collection efficiencies and effective migration velocities obtained from a laboratory precipitator with those predicted by the model using the measured electrical conditions.................................	70
4	Experimental and theoretical voltage-current curves for the laboratory precipitator..............	73
5	Comparison of experimental fractional collection efficiencies obtained from a laboratory precipitator with those predicted by the model using theoretical voltage-current calculations............	74
6	Comparison of experimental fractional collection efficiencies and effective migration velocities obtained from a full-scale, cold-side precipitator with those predicted by the model..................	78
7	Comparison of experimental discrete outlet mass loadings obtained from a full-scale, cold-side precipitator with those predicted by the model......	79
8	Comparison of experimental fractional collection efficiencies and effective migration velocities obtained from a full-scale, hot-side precipitator with those predicted by the model..................	82
9	Comparison of standard and dynamic rapping reentrainment calculations...........................	86
10	Collection efficiency calculated by the internal data set as a function of resistivity and specific collection area (SCA).............................	87
11	Effect of particle size distribution on overall mass collection efficiency.........................	91

Number Page

12 Effect of specific collection area on overall mass collection efficiency.............................. 94

13 Experimental voltage-current curves used in Example 7.. 96

14 Effect of current density on overall mass collection efficiency.............................. 98

15 Effects of nonideal conditions on overall mass collection efficiency.............................. 102

16 Distribution of mass in the total outlet emissions for different particle size distributions in the "rapping puff"................................... 103

17 Effects of the "rapping puff" particle size distribution on the particle size distribution of the total emissions................................ 104

18 Effect of resistivity on overall mass collection efficiency... 107

19 Comparison of results obtained from rigorous application of the model and the estimation procedure... 110

TABLES

Number		Page
1	Reduced Effective Negative Ion Mobilities for Various Gas Compositions............................	8
2	Values of Viscosity for Air at Various Temperatures and Water Contents.........................	9
3	Opacity Related Input Data..........................	24
4	User Options When the Operating Voltage and Current Are Not Known......................................	46-47
5	Summary of Programming Options......................	50
6	Effects of Varying NEST and NCALC...................	51
7	Functions Tagged for Easy Removal...................	66
8	Input Data for Example 1............................	71
9	Input Data for Example 2............................	75
10	Input Data for Example 3............................	77
11	Input Data for Example 4............................	81
12	Input Data for Example 5............................	83-84
13	Input Data for Example 6............................	85
14	Input Data for Example 7............................	90
15	Input Data for Example 8............................	93
16	Input Data for Example 9............................	97
17	Input Data for Example 10...........................	101
18	Input Data for Example 12...........................	108

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METRIC CONVERSION FACTORS

Length:	ft = 3.28 * m
	in. = 0.394 * cm
Area:	ft^2 = 10.8 * m^2
SCA:	ft^2/(1000 CFM) = 5.05 * m^2/(m^3/sec)
Linear flow:	ft/sec = 3.28 * m/sec
Volume flow:	ft^3/min = 2120 * m^3/sec
Mass:	grain = 15.6 * g
Mass loading:	grn/SCF = 0.442 * g/m^3
Temperature:	°F = (9/5 * °C) + 32
Current density:	μA/ft^2 = 0.926 * nA/cm^2

SECTION 1

INTRODUCTION

The objectives of this manuscript are to provide a comprehensive description of how to use the computer program which performs the calculations in the mathematical model of electrostatic precipitation and to instruct in the proper usage of the model. The text deals with the input and output data associated with the computer program and with applications of the model. The theories and numerical techniques associated with the model and the details of the internal workings of the computer program are presented in Volume 1. Since Volume 1 provides the basic understanding of what the computer program does, it is strongly recommended that Volume 1 be studied before one attempts to utilize the contents in Volume 2. Volumes 1 and 2 should be used in conjunction with one another in order to obtain the fullest benefits of the model.

In this text, the input and output data associated with the computer program are described in detail and are presented in various forms covering the different uses of the model. Any restrictions on the input variables are discussed and guidelines are given for specifying the values of those input variables whose values may be uncertain.

The different ways in which the model can be used to analyze and project precipitator performance are discussed and demonstrated in examples. Comparisons of the predictions of the model with experimental data are presented and the agreement obtained is discussed. For all examples utilizing the computer program, the input data are presented in tabular form in the main text and the computer printouts of the output data are presented in appendices. Thus, a user can easily run the example cases and has a means of checking his results.

Methods for using the model in troubleshooting and sizing precipitators are discussed. These methods employ the various applications of the model in specific ways in order to obtain specific information. Since, in applying the model to troubleshooting and sizing precipitators, it is very important that the model be used properly, a section of the text is devoted to emphasizing precautions which must be taken when using the model for these purposes.

SECTION 2

CONCLUSIONS AND RECOMMENDATIONS

Revision 3 of the electrostatic precipitator model offers greater versitility and requires less computer time than previous versions.[1,2,3] Comparisons of the predictions of the model with experimental data indicate that the model can be used successfully to describe the operation of electrostatic precipitators. The effect on precipitator performance of changes in particle size distribtuion, specific collection area, current density, nonideal conditions, and the resistivity of the collected particulate layer can be easily obtained. In those cases where the use of computer time is an important consideration, the application of an estimation procedure can result in considerable savings in computer time. Discussions on the use of the model for troubleshooting and sizing of precipitators and on precautions to use in applying the model provide a basis for practical applications of the model.

Although the mathematical model of electrostatic precipitation presented in this report represents a significant improvement over the previous version, additional work can be performed in order to improve the fundamental basis and user oriented aspects of the model. For this work it is recommended that the following research be pursued:

1. Theoretical and experimental studies of the effects of particles on the electrical conditions should be continued in order to better describe the effect on the electric field distribution.

2. Theoretical and experimental studies of electrical breakdown mechanisms in the collected particulate layer should be given greater emphasis in an attempt to acquire the capability of theoretical prediction of when electrical breakdown will ensue for a given value of dust resistivity.

3. Since the model underpredicts field-measured collection efficiencies for fine particles without the use of empirical correction factors, theoretical and experimental studies should be continued in order to remove the empiricism or to explain the discrepancy. These studies should include a reevaluation of the theories presently used in the model and an examination of those effects which are presently neglected such as particle charging near corona wires and phenomena due to the gas flow field.

4. Theoretical and experimental studies should be performed on the mechanisms involved in separating the dust layer from the collection plates during a rap and on the quantity and nature of the dust reentrained into the gas flow. This would provide an analytical method of determining the nature of the reentrained dust used in the dynamic rapping procedure and reduce the dependence on empirically derived data. This change would increase the usefulness of the model in optimizing the electrical operating conditions and the rapping schedule and intensity of an ESP.

5. Alternative numerical techniques need to be investigated and implemented in order to make the computer program run significantly faster.

SECTION 3

PRECAUTIONS TO TAKE IN USING THE MODEL

In order to get meaningful data from the model, it is necessary that the input data be correct. Some precautions which apply to the use of the model are listed below.

Precaution 1: The inlet particle size distribution which is utilized in the model should be the actual size distribution which will be seen by the precipitator. Also, in using measured particle size distributions, make sure the size distribution has been obtained based on the true density of the particles. The model must have particle size distributions based on the true diameters of the particles. Thus, particle size distributions based on aerodynamic diameters or other non-physical diameters are not appropriate for use in the model and they must be redetermined based on the true diameters.

Precaution 2: The bulk resistivity of the particles to be collected should be measured before using the model. An accurate knowledge of the resistivity is needed for calculating the voltage-current curves and operating points of a precipitator using the internal data set. When the operating points are known, the resistivity may be used to estimate the maximum allowable current density. The resistivity measurement should be made in situ or under simulated conditions in the laboratory or, preferably, by both means. In making this measurement, all environmental conditions that will prevail in the precipitator should be duplicated in order to ensure that the measured value will be representative of that found in the precipitator. The most critical of these conditions are temperature, gas composition, moisture content, and electric field strength in the particulate layer.

Precaution 3: In specifying the electrical operating conditions to be used in the model, make sure the maximum allowable current density is not exceeded. The model does not account for the detrimental effects of excessive sparking and back corona and, if either of these conditions exists, the model will overpredict particle collection efficiencies when the voltages and currents which produce these conditions are used. Although the model can be used in a troubleshooting procedure to determine whether or not excessive sparking or back corona is occurring in a precipitator, it is recommended that the model not be used to simulate the operation of a precipitator in which either of these conditions exists since no method is presently available for determining the current which is effective in the precipitation process. If excessive sparking or back corona exists in a precipitator, then measures should be taken to correct this problem before the model is used. The measured value of resistivity and Figure 1 can be used to help determine the maximum allowable current density. However, for collected particulate layers with high resistivities (>10^{12} ohm-cm), it may not be possible to eliminate entirely the effects of back corona. When using the model to size a precipitator, always use the measured value of resistivity, Figure 1, and any experimental data from similar situations in order to make a reasonable estimate of the maximum allowable current density. In sizing a precipitator, it must be emphasized that care must be taken in specifying the maximum allowable current density since a reasonable estimate of this quantity is necessary for predicting the optimum collection area. Significant overestimation of the maximum allowable current density must be avoided in order to prevent severe undersizing of a precipitator.

Fig 1
p 6

Precaution 4: When using the option for calculating ESP operating points using the procedure in subroutine ELFD2 (NVI = 2) rather than the internal data set, care must be taken in specifying a value for the roughness factor of the discharge electrodes and in interpreting the results of the calculation. In practice, the values of the roughness factor range between 0.5 and 1.0 and small changes in the value of this quantity can result in significant changes in the theoretical voltage-current curve. Decreasing the value of the roughness factor leads to higher ion densities near the discharge electrode and to higher currents for the same applied voltage. Since it is impossible to predict what condition the discharge electrodes will be in once a precipitator is constructed and since this condition will change during the operation of the precipitator, it is difficult to determine what value of the roughness factor is appropriate for sizing a new precipitator. Representative values of this quantity might be determined by fitting voltage-current characteristics for similar situations. Alternatively, calculations can be made for several values of the roughness factor in the range 0.5-1.0 in order to produce various possible combinations of operating applied voltage and current and the sizing of a precipitator can be based on a value of this quantity that produces conservative estimates of overall mass collection efficiency. It should be kept in mind that if the discharge electrodes become completely covered with material during operation, that this has the effect of increasing the size of the discharge electrode in addition to a roughness of the surface. This situation should be prevented by periodic rapping or vibration of the discharge electrodes with sufficient force to keep large buildups of material off the electrodes.

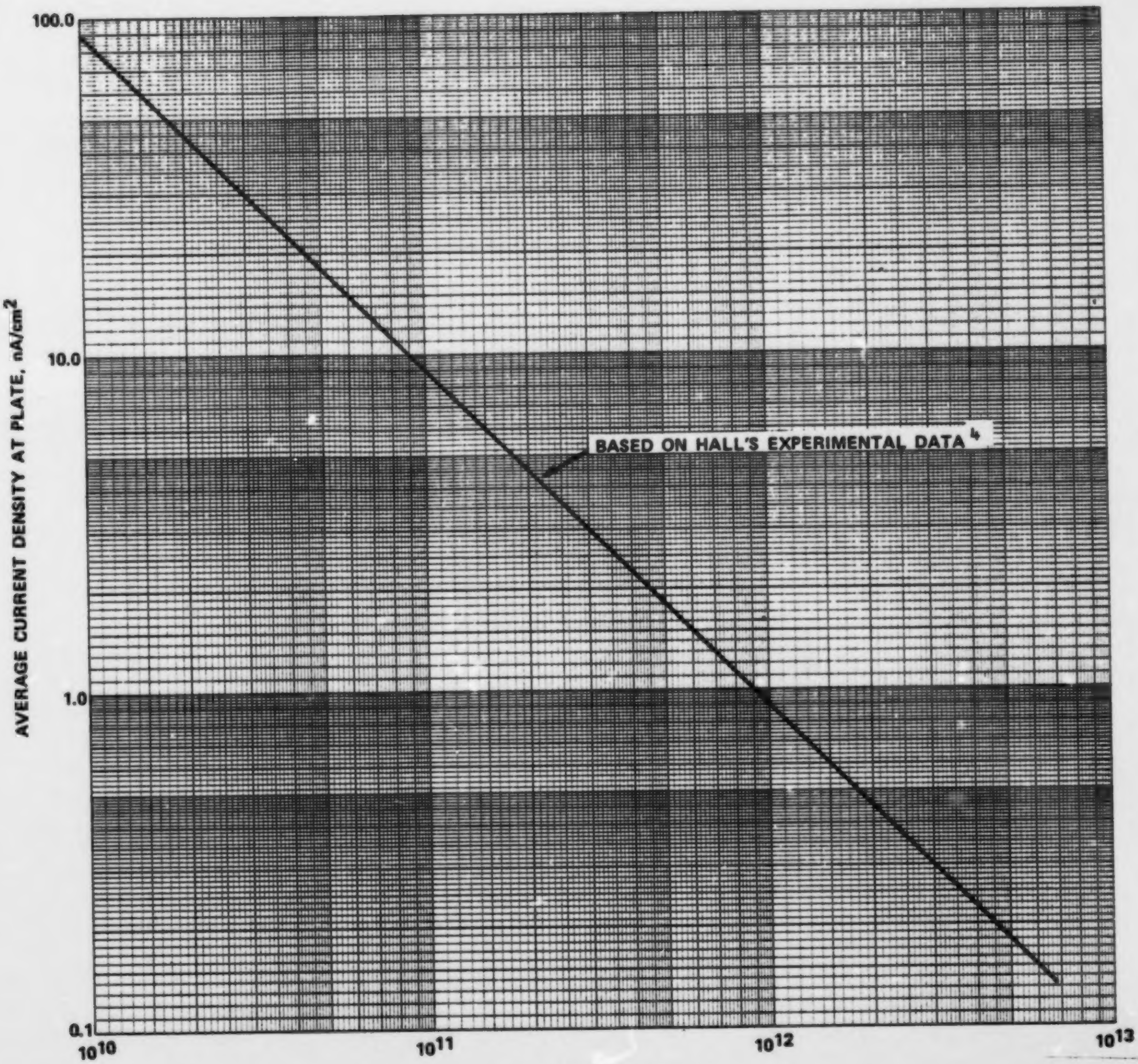

Figure 1. Experimentally determined effect of resistivity on allowable current density in a precipitator.

Precaution 5: The applied voltage, current density, and electric field at the plate are sensitive to the value of reduced effective ion mobility that is used in the model. If in situ or laboratory measurements of effective ion mobility can not be obtained, then make sure the value which is used is consistent with those values given in Table 1. p 8

Precaution 6: Recent studies[5] have revealed peculiar electrical operating conditions in certain hot-side precipitators. One unexpected observation is very steep current-voltage curves for the electrical sets. For hot-side precipitators, the expected range (≈ 20-30 kV) from the corona starting voltage to the maximum voltage would be on the order of 10 kV or more, whereas in these cases the range (≈ 18-23 kV) for the outlet electrical fields is on the order of 5 kV or less. This type of behavior results in low operating voltages in the outlet electrical fields. Another unexpected observation is that the voltage waveforms for the electrical fields of the precipitator show the voltage decaying to a value less than the corona starting voltage. This indicates that a mechanism in addition to the applied voltage is sustaining the current. However, measured values of resistivity and electrical breakdown strength do not lend support for arguing that the layer collected at the plate was experiencing electrical breakdown. These phenomena associated with hot-side precipitators are under investigation at the present time. Whether they are due to the properties of the gas, the properties of the collected particulate layers, or a combination of both is yet to be established firmly. As a consequence of the possible limitation in applied voltage, care must be taken in choosing electrical operating conditions to be used in the model for simulating the performance of hot-side precipitators. When sizing hot-side precipitators, it is suggested that recent voltage-current data for different installations be obtained and used as a guide in choosing the electrical operating conditions.

Precaution 7: Make sure the value of gas viscosity that is used in the model is consistent with the values given in Table 2. The gas viscosity has a significant effect of particle migration velocities and should be specified as accurately as possible. p 9

Precaution 8: The electric field calculation is performed on a grid which extends from wire to plate (x direction) and from wire to halfway between wires (y direction). Higher calculation accuracy is achieved by using more grid points at the cost of longer computer run time. If the operating voltages and currents are specified (NVI = 1), the number of grid points in the x direction (NX) and y direction (NY) should be at least 11 and 9, respectively. If the operating points are being calculated in subroutine EFLD2 (NVI = 2), NX and NY should both have the maximum value of 15.

TABLE 1

REDUCED EFFECTIVE NEGATIVE ION MOBILITIES FOR VARIOUS GAS COMPOSITIONS

Gas Composition (Volume Percent)					Reduced Effective Ion Mobility (cm^2/V-sec)
N_2	CO_2	O_2	SO_2	H_2O	
				100.0	0.67 ± 0.17[a]
		100.0			2.46 ± 0.06[b]
	100.0				1.08 ± 0.03[b]
			100.0		0.35[c]
	(Laboratory Air)				1.03[d]
	(Laboratory Air)				1.26 - 1.96[e]
79.4	14.7	4.6	0.2	0.6	5.39[f]
73.5	13.6	4.2	0.2	8.4	2.93[f]
65.9	12.2	3.8	0.2	17.8	2.23[f]
71.0	11.2	3.7	0.0	14.0	2.35[f]
75.7	11.6	3.2	0.0	9.4	3.02[f]
75.1	11.5	3.2	0.1	9.9	2.74[f]
78.5	10.9	3.6	0.0	7.0	3.36[f]
78.3	19.8	3.6	0.1	7.0	2.67[f]
77.9	10.8	3.6	0.3	7.0	2.70[f]
77.6	10.7	3.7	0.7	7.0	2.43[f]

---

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e. J. Bricard, M. Cabane, G. Modelaine, and D. Vigla, Aerosols and Atmospheric Chemistry. Edited by G. M. Hidy, New York, New York, 27 (1972).

f. H. W. Spencer, III, "Experimental Determination of the Effective Ion Mobility of Simulated Flue Gas." In Proceedings of 1975 IEEE-IAS Conference, September 28, 1975, Atlanta, Georgia.

TABLE 2. VALUES OF VISCOSITY FOR AIR AT VARIOUS TEMPERATURES AND WATER CONTENTS*

	Percent H_2O										
°C	0	1	2	3	4	5	6	7	8	9	10
10	1.767	1.758	1.748	1.739	1.730	1.721	1.712	1.702	1.693	1.684	1.675
20	1.810	1.801	1.792	1.783	1.774	1.765	1.755	1.746	1.737	1.728	1.719
30	1.854	1.844	1.835	1.826	1.817	1.808	1.799	1.790	1.780	1.771	1.762
40	1.900	1.887	1.878	1.869	1.860	1.850	1.841	1.832	1.823	1.814	1.805
50	1.938	1.929	1.920	1.911	1.902	1.892	1.883	1.874	1.865	1.856	1.847
60	1.979	1.970	1.961	1.952	1.943	1.934	1.925	1.916	1.907	1.898	1.888
70	2.020	2.011	2.002	1.993	1.984	1.975	1.966	1.957	1.948	1.939	1.930
80	2.059	2.050	2.042	2.033	2.024	2.015	2.006	1.997	1.988	1.979	1.970
90	2.099	2.090	2.081	2.072	2.063	2.054	2.046	2.037	2.028	2.019	2.010
100	2.137	2.129	2.120	2.111	2.102	2.093	2.085	2.076	2.067	2.058	2.049
110	2.175	2.167	2.158	2.149	2.140	2.132	2.123	2.114	2.105	2.097	2.088
120	2.213	2.204	2.195	2.189	2.178	2.169	2.161	2.152	2.143	2.135	2.126
130	2.250	2.241	2.232	2.224	2.215	2.207	2.198	2.189	2.181	2.172	2.164
140	2.286	2.277	2.269	2.260	2.252	2.243	2.235	2.226	2.218	2.209	2.201
150	2.321	2.313	2.304	2.296	2.288	2.279	2.271	2.262	2.254	2.245	2.237
160	2.356	2.348	2.339	2.331	2.323	2.315	2.306	2.298	2.289	2.281	2.273
170	2.390	2.382	2.374	2.366	2.358	2.349	2.341	2.333	2.325	2.316	2.308
180	2.424	2.416	2.408	2.400	2.392	2.383	2.375	2.367	2.359	2.351	2.343
190	2.457	2.449	2.441	2.433	2.425	2.417	2.409	2.401	2.393	2.385	2.377
200	2.489	2.482	2.474	2.466	2.458	2.450	2.442	2.434	2.426	2.418	2.410
210	2.521	2.513	2.506	2.498	2.490	2.482	2.475	2.467	2.459	2.451	2.443
220	2.552	2.545	2.537	2.530	2.522	2.514	2.507	2.499	2.491	2.483	2.476
230	2.583	2.575	2.568	2.560	2.553	2.545	2.538	2.530	2.523	2.515	2.507
240	2.613	2.606	2.598	2.591	2.583	2.576	2.569	2.561	2.554	2.546	2.539
250	2.642	2.635	2.628	2.621	2.613	2.606	2.599	2.592	2.584	2.577	2.570
260	2.671	2.664	2.657	2.650	2.643	2.636	2.628	2.621	2.614	2.607	2.600
270	2.699	2.692	2.685	2.678	2.671	2.664	2.657	2.650	2.643	2.636	2.629
280	2.727	2.720	2.713	2.706	2.700	2.693	2.686	2.679	2.672	2.665	2.658
290	2.754	2.747	2.740	2.734	2.727	2.720	2.714	2.707	2.700	2.694	2.687
300	2.780	2.773	2.767	2.761	2.754	2.748	2.741	2.734	2.728	2.721	2.715

$\times 10^{-5}$ kg/(m-sec)

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*Calculations according to:
C.R. Wilke. A Viscosity Equation for Gas Mixtures. J. Chem. Phy., 18(4):517-519 (April, 1950).

Precaution 9: The procedures which are used in the model to estimate the effects of nonideal conditions yield the best results when applied to high efficiency precipitators. If nonideal conditions (especially particle reentrainment) exist to a large extent in a precipitator, then the deviation from the exponential-type relationship which is used in the model to describe particle collection can be so large as to result in an inadequate representation by the model. In this type of situation, a set of nonideal parameters that results in a good representation of nonideal conditions for one gas volume flow may be completely different at another gas volume flow. Thus, in sizing a precipitator to collect particles which are easily reentrained (due to low resistivity, low density, etc.), care must be taken in choosing an appropriate set of nonideal parameters that will be characteristic of the actual operating conditions. For this type of application, errors in sizing can be reduced by designing the precipitator such that the gas velocity through the precipitator is as low as possible.

Precaution 10: When sizing a precipitator, never base the final size on calculations from the estimation procedure. Always check the size obtained from the estimation procedure with that predicted by the more rigorous calculation and, if necessary, make the proper adjustment to the size of the precipitator.

SECTION 4

USE OF THE MODEL FOR SIZING OF PRECIPITATORS

The mathematical model of electrostatic precipitation can be used as a guide in sizing precipitators. Although this method of sizing precipitators can be very successful, care must be taken to ensure proper usage of the model and to prevent the use of erroneous input data. Misuse of the model could result in a large error in sizing a precipitator.

When using the model for the purpose of sizing a precipitator, certain data which are used as input to the model should be obtained from measurements made using the actual gas stream or one which will be very similar to the actual gas stream. If a gas stream other than the actual one is used to obtain representative data, steps should be taken to assure that the process variables producing the effluent gas stream and particles are not too different. Also, it is very important that the temperature and composition of the gas stream be close to that which will be experienced in the precipitator to be sized.

The following is a list and discussion of those quantities whose values should be determined from measurements under conditions similar to those which will be experienced in the precipitator to be sized:

- The temperature, pressure, and composition of the gas stream should be measured.
- The particle size distribution and mass loading in the gas stream should be measured at a location from the source that would be representative of where the gas stream would enter the precipitator.
- The bulk resistivity of the particles should be measured both *in situ* and in the laboratory. In making these measurements, the gaseous environment must not only be preserved but, in addition, the electric field strength at which the measurements are made must be close to that which will be experienced in the precipitator in order to obtain the appropriate measurement. If agreement can not be obtained between the *in situ* and laboratory measurement, then the higher of the two values should be used in order to size the precipitator.

- The effective mobility of the negative ions which would be produced during negative corona discharge in the gas stream should be measured.

If any or all of the above quantities are not measured or can not be measured, then their values can only be estimated by using the best data available and prior experience for similar sets of conditions. Using values of these quantities that are not obtained from measurements with the actual or a similar gas stream is risky and these values should be estimated in a conservative manner.

Once the values of the quantities discussed above are determined, the model can be used to predict the precipitator size needed for this application. The initial step is to use the internal data set to estimate a set of ESP dimensions and operating conditions which will achieve the desired collection efficiency. Using these data as a starting point, a more vigorous study must be undertaken to determine a final set of dimensions and operating conditions. The steps to be taken in this study are discussed below.

Step 1: Establish an estimate of the electrical conditions under which the precipitator should operate.

In establishing an estimate of the electrical operating conditions, a determination of the maximum allowable current density should be made first. The maximum allowable current density can be estimated by using the determined value of ash resistivity and the curve given in Figure 1. If voltage-current data are available for similar conditions, then these should also be used in helping to determine the maximum allowable current density.

Once the maximum allowable current density is estimated, then the applied voltages which will produce this current density in the different electrical sections must be estimated. These voltages may be obtained from voltage-current data which are available for similar conditions except it is not necessary that the ash resistivity be duplicated. Alternatively, the model can be used with the option which calculates voltage-current curves for a wire-plate geometry in order to determine voltage-current characteristics with the effect of resistivity being ignored. Then, the applied voltages necessary to produce the maximum allowable current density can be estimated. In utilizing the voltage-current calculation, a value for the roughness factor of the discharge electrodes must be specified. The value of this parameter normally lies between 0.5 and 1.0 and small changes in the value lead to significantly different results. Since the value of this parameter is difficult to project in advance and the value changes during the operation of the precipitator, care must be taken in specifying this value and in analyzing the results obtained. Calculations used to size the precipitator should be made for several values of the roughness factor between 0.5 and 1.0 and the most conservative prediction of precipitator performance should be used as the basis for sizing the precipitator.

Also, if values of the roughness factor in a particular range yield results that are obviously out of line with similar applications, then this range should be eliminated from consideration.

Since the ash resistivity is difficult to determine precisely and environmental changes can produce significant changes in its value, the size of a precipitator should be determined based on a maximum allowable current density which is estimated based on a somewhat higher value of resistivity than anticipated. A reasonable and conservative approach might be to base the estimated maximum allowable current density on a value of resistivity that is one-half an order of magnitude greater than the anticipated value.

Step 2: Determine the geometrical parameters to be used.

At this point, the geometrical characteristics of the precipitator should be established since these data are necessary as input to the model. The values of the plate spacing, discharge electrode spacing, and diameter of the discharge electrodes which are used in the model must be the actual values. In order to size the precipitator, it is not necessary to know the actual values of the cross-sectional area, height, area, and number of the plates, length of the electrical sections, or total electrified length. Although the values of these quantities can be chosen arbitrarily, they should be as representative as possible.

In the model, different overall mass collection efficiencies can be determined for different specific collection areas and then, based on the actual gas volume flow through the precipitator, the total collection plate area necessary to achieve a given efficiency can be determined. Knowing the required collection plate area, the precipitator can be designed with respect to cross-sectional area, plate height, and length. In designing the precipitator so that it will have the required collection plate area, certain considerations should be made. First, the height of the collection plates should not be too high since this can lead to increased reentrainment from rapping and to greater difficulty in providing sufficient rapping force to the entire area of the plate. In practice, the height of collection plates ranges from approximately 3.05 (10) to 12.2 (40) meters (feet). Second, the precipitator should be long enough so that it can contain several baffled, independent electrical sections. Increasing the number of baffled electrical sections leads to better operating electrical conditions and reduced losses in collection efficiency due to gas sneakage and hopper boil-up. Third, the gas velocity through the precipitator should be 1.53 m/sec (5 ft/sec) or less in order to help prevent reentrainment without rapping and to allow sufficient residence time to recollect material reentrained due to rapping.

Step 3: Determine the nonideal conditions for which the precipitator will be sized.

Since a certain degree of a gas flow nonuniformity and gas bypassage of electrified regions and/or particle reentrainment without rapping can be expected to exist in a precipitator, these factors must be considered in sizing the precipitator. Experience in simulating the operation of full-scale, industrial precipitators indicates that values of $\sigma_g = 0.25$ and $S = 0.1$ are appropriate for modeling precipitators which are in good working condition. Losses in overall mass collection efficiency due to rapping reentrainment are built into the model and can not be varied without changing the computer program itself. Since the procedure which determines the effect of rapping reentrainment on precipitator performance is based on average data acquired from six different full-scale precipitators, the effects of rapping reentrainment might not be estimated in a conservative manner.

If a conservative approach is taken in sizing the precipitator, then the values of σ_g and S should be taken to be somewhat higher than 0.25 and 0.1, respectively. Values of $\sigma_g = 0.4$ and $S = 0.2$ should be conservative. This value of S should also allow for above average losses in collection efficiency due to rapping reentrainment. If the precipitator is sized in a conservative manner, then the chances that the precipitator will be able to meet the particulate emissions standards once it is built are improved even though undesirable nonideal conditions exist. As a consequence, the process producing the emissions does not have to be shut down until the problems with the precipitator are diagnosed and corrected. The problems with the precipitator can be diagnosed with the troubleshooting procedure while the precipitator is in operation and appropriate corrective measures can be made during a scheduled shut down. Thus, in many cases, the added cost of a conservative design can be partially or fully recovered.

Step 4: Consider the effect of adverse changes in particle size distribution in sizing the precipitator.

Since any decrease in the mass median diameter or increase in the dispersiveness of the inlet particle size distribution will result in a fundamental reduction in precipitator performance, this factor should be considered in sizing a precipitator. Any changes in the process variables controlling the source of the emissions can result in significant changes in particle size distribution. Thus, the possibility of a change from the anticipated particle size distribution to a less favorable one should be incorporated into the sizing procedure. In a conservative approach, the measured or anticipated inlet particle size distribution can be fit to a log-normal distribution and the fitted mass median diameter and geometric standard deviation can be decreased and increased by 25%, respectively. These new values should then be used in the model in order to obtain the inlet particle size distribution for use in sizing the precipitator.

Step 5: Generate a curve of overall mass collection efficiency versus specific collection area.

At this point, since all appropriate input data have been measured or can be determined, the computer program for the mathematical model can be executed in order to size the precipitator. The precipitator can be sized by generating a curve of overall mass collection efficiency versus specific collection area. This can be done by using a basic data set and shortened data sets as discussed in the section which describes the input data.

Based on the curve of overall mass collection efficiency versus specific collection area and the particulate emissions standard, the precipitator size needed to attain the required efficiency can be determined. In sizing the precipitator in a conservative manner, the precipitator should be sized to attain an efficiency which is somewhat higher than that which is required. This is necessary in order to provide a margin of safety in design irrespective of any uncertainties in operating parameters and of any nonidealities which might exist. In order to provide this margin of safety, the projected collection plate area needed to attain the required efficiency should be increased by a certain percentage, possibly 10-15%. This added collection plate area is also an advantage in that it offers the possibility that the precipitator will be able to adequately treat gas flows which are somewhat higher than the design gas flow.

Step 6: Allow for the outage of electrical sections.

In designing the precipitator, a high degree of electrical sectionalization should be provided. As stated previously, this leads to improved electrical operating conditions. In addition, if certain electrical sections are not working, this condition does not disable a large portion of the precipitator.

In sizing a precipitator, proper allowance should be made for the possibility that from time to time certain electrical sections will not be functioning. This can be done by increasing the collection plate area obtained in step 4. The additional collection plate area should be provided in the form of added electrical sections. If reliable data or past experiences are not sufficient for estimating the number of electrical sections that might be inoperable at any given time, then a reasonable approach might be to add an extra electrical section for approximately every four electrical sections that are required in step 4.

The guidelines and procedure presented in this section cover the important considerations which must be made in sizing an electrostatic precipitator. If the guidelines and procedure are followed correctly, then the mathematical model of electrostatic precipitation can be a valuable tool for sizing electrostatic precipitators. Since the procedure includes reasonable conservative measures to account for several different uncertainties, the cumulative effect should lead to a precipitator which is sized conservatively but not excessively oversized.

SECTION 5

DESCRIPTION OF INPUT DATA

GENERAL DESCRIPTION

The format of the original computer program which performs the calculations in the model for electrostatic precipitation has been re-structured to make the inputting of data less cumbersome. The number of cards which is necessary to input data has been reduced significantly by allowing different operating conditions to be analyzed from one basic set of input data. Due to the fact that several options are available in using the model, the number of cards and type of information in the input data may vary from one set of data to the next. Thus, it is necessary for the user to familiarize himself with the logic associated with the input data in order to ensure that the desired operations will be performed.

The input variables may be read into the program entirely in metric units or in mixed British and metric units depending on the value of the variable MODL described below. All input data are converted to metric units prior to performing the calculations. The input variables and format specifications are discussed in detail in the following subsection. Where both British and metric units are given, the British units are to be used when mixed units are selected and the metric when all-metric input is selected. Figure 2 contains a flow chart which shows the logic involved in entering the data.

CONSTRUCTION OF THE BASIC DATA SET

The following is a sequential listing of the variables in the first group of data which is read in, along with the descriptions of the variables and the format specifications.

(1) NENDPT is the number of discrete points on a cumulative percent versus particle diameter curve. NENDPT is specified by the user and must have a value of at least 1 but not greater than 21. After the collection efficiency has been calculated for one data set, the program will begin reading data for another efficiency calculation starting with this data group. If NENDPT has a value of 99, the program terminates. Thus this data group will be

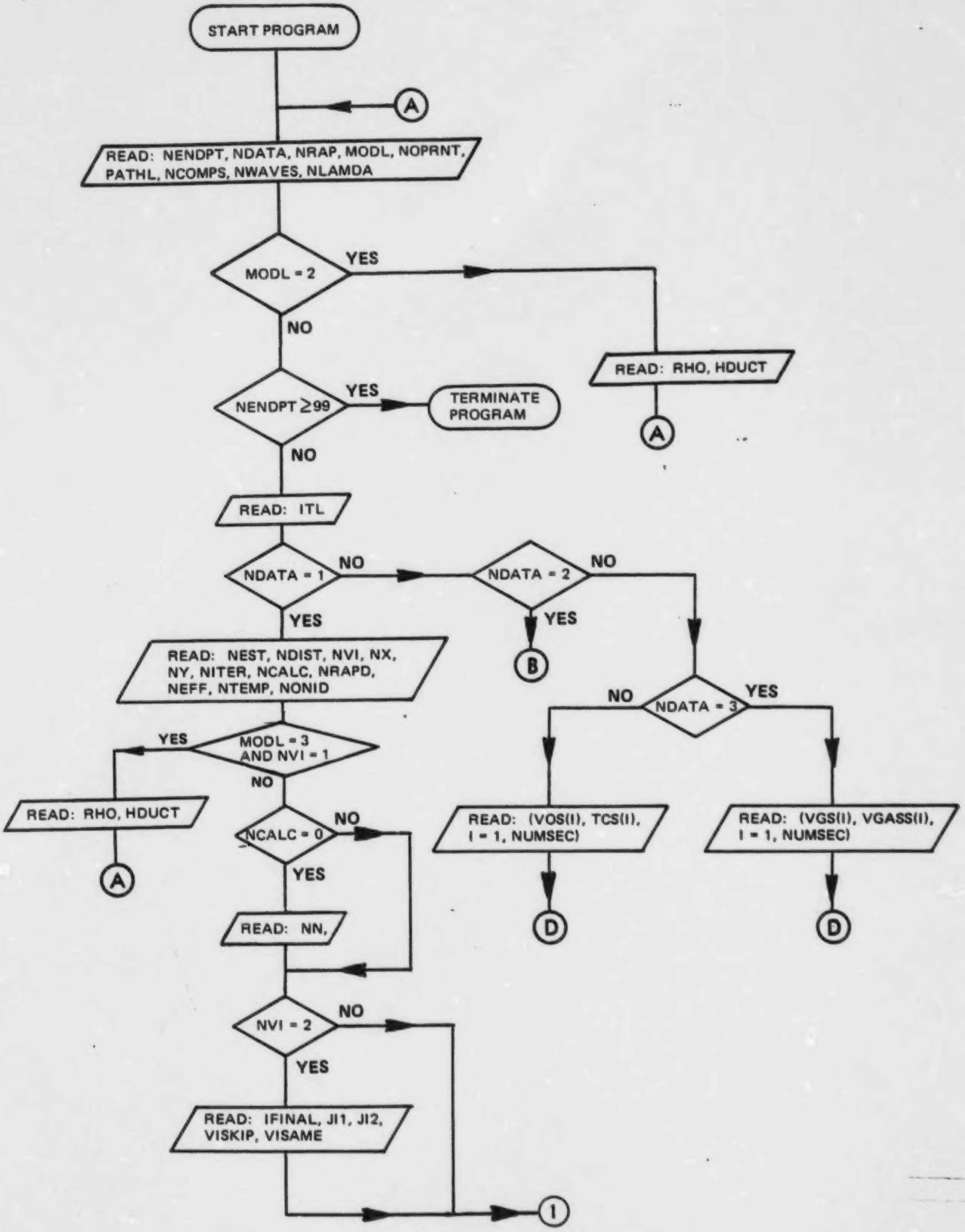
START PROGRAM
A
READ: NENDPT, NDATA, NRAP, MODL, NOPRNT, PATHL, NCOMPS, NWAVES, NLAMDA
MODL = 2
YES
NO
READ: RHO, HDUCT
A
NENDPT ≥99
YES
TERMINATE PROGRAM
NO
READ: ITL
NDATA = 1
NO
NDATA = 2
NO
YES
B
YES
READ: NEST, NDIST, NVI, NX, NY, NITER, NCALC, NRAPD, NEFF, NTEMP, NONID
NO
NDATA = 3
YES
MODL = 3 AND NVI = 1
YES
NO
READ: RHO, HDUCT
A
NCALC = 0
NO
YES
READ: (VOS(I), TCS(I), I = 1, NUMSEC)
READ: (VGS(I), VGASS(I), I = 1, NUMSEC)
D
D
READ: NN,
NVI = 2
NO
YES
READ: IFINAL, JI1, JI2, VISKIP, VISAME
1

Figure 2. *Flow chart for the input data logic (Sheet 1 of 4).*

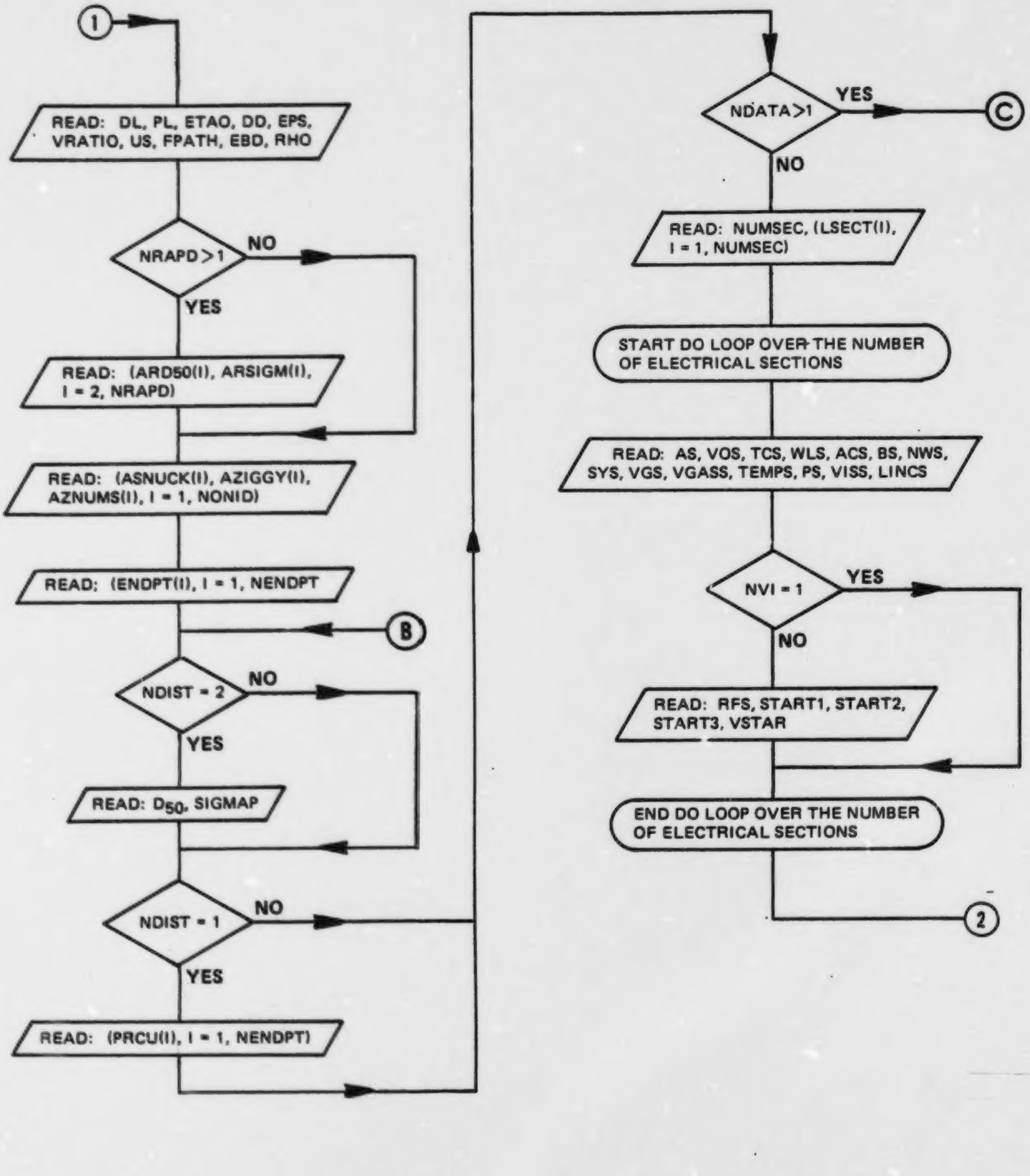
1
READ: DL, PL, ETAO, DD, EPS, VRATIO, US, FPATH, EBD, RHO
NRAPD > 1
NO
YES
READ: (ARD50(I), ARSIGM(I), I = 2, NRAPD)
READ: (ASNUCK(I), AZIGGY(I), AZNUMS(I), I = 1, NONID)
READ: (ENDPT(I), I = 1, NENDPT
B
NDIST = 2
NO
YES
READ: D50, SIGMAP
NDIST = 1
NO
YES
READ: (PRCU(I), I = 1, NENDPT)
NDATA > 1
YES
C
NO
READ: NUMSEC, (LSECT(I), I = 1, NUMSEC)
START DO LOOP OVER THE NUMBER OF ELECTRICAL SECTIONS
READ: AS, VOS, TCS, WLS, ACS, BS, NWS, SYS, VGS, VGASS, TEMPS, PS, VISS, LINCS
NVI = 1
YES
NO
READ: RFS, START1, START2, START3, VSTAR
END DO LOOP OVER THE NUMBER OF ELECTRICAL SECTIONS
2

Figure 2. *Flow chart for the input data logic (Sheet 2 of 4).*

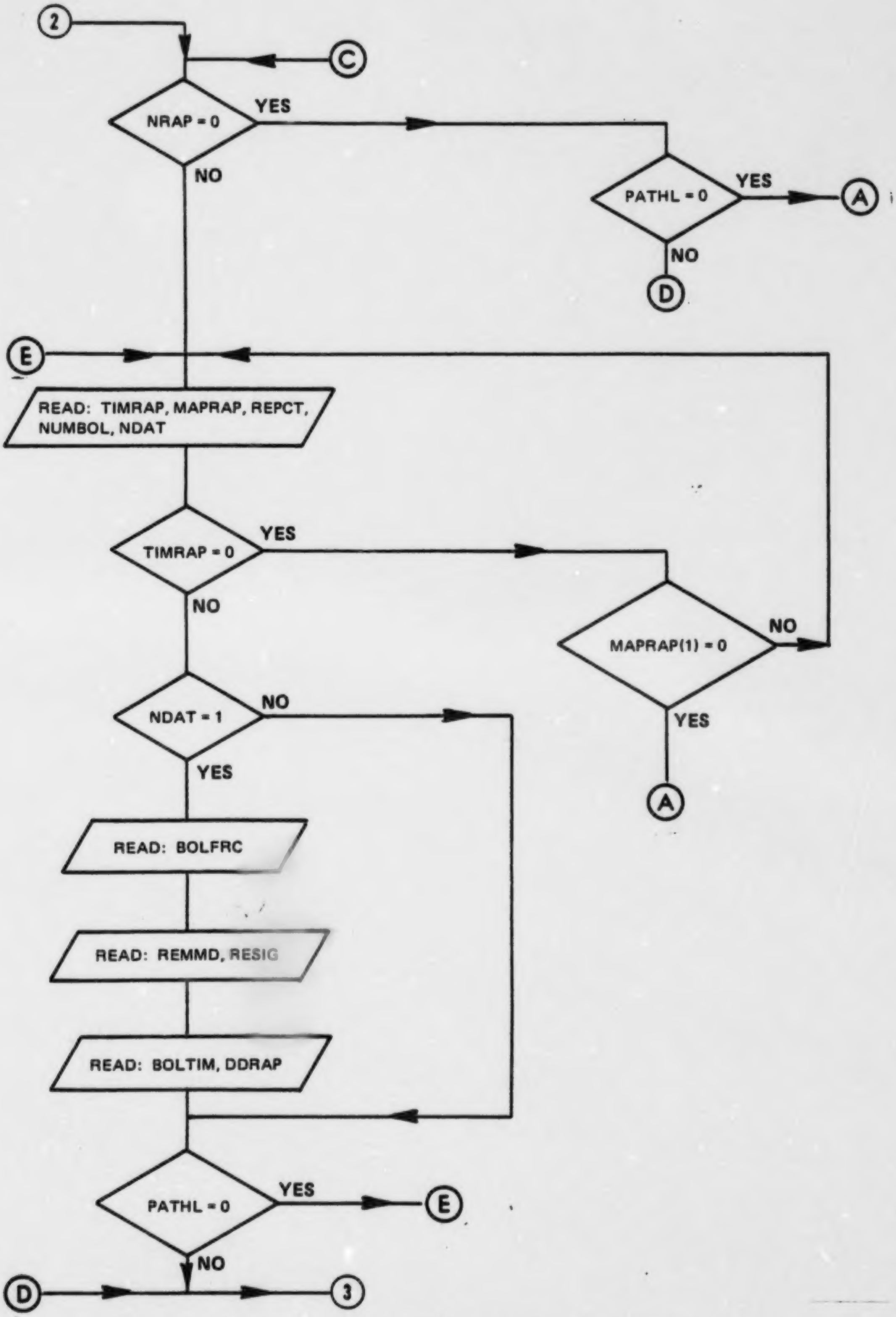
2
C
NRAP = 0
YES
NO
PATHL = 0
YES
A
NO
D
E
READ: TIMRAP, MAPRAP, REPCT, NUMBOL, NDAT
TIMRAP = 0
YES
NO
MAPRAP(1) = 0
NO
YES
A
NDAT = 1
NO
YES
READ: BOLFRC
READ: REMMD, RESIG
READ: BOLTIM, DDRAP
PATHL = 0
YES
E
NO
D
3

Figure 2. *Flow chart for the input data logic (Sheet 3 of 4).*

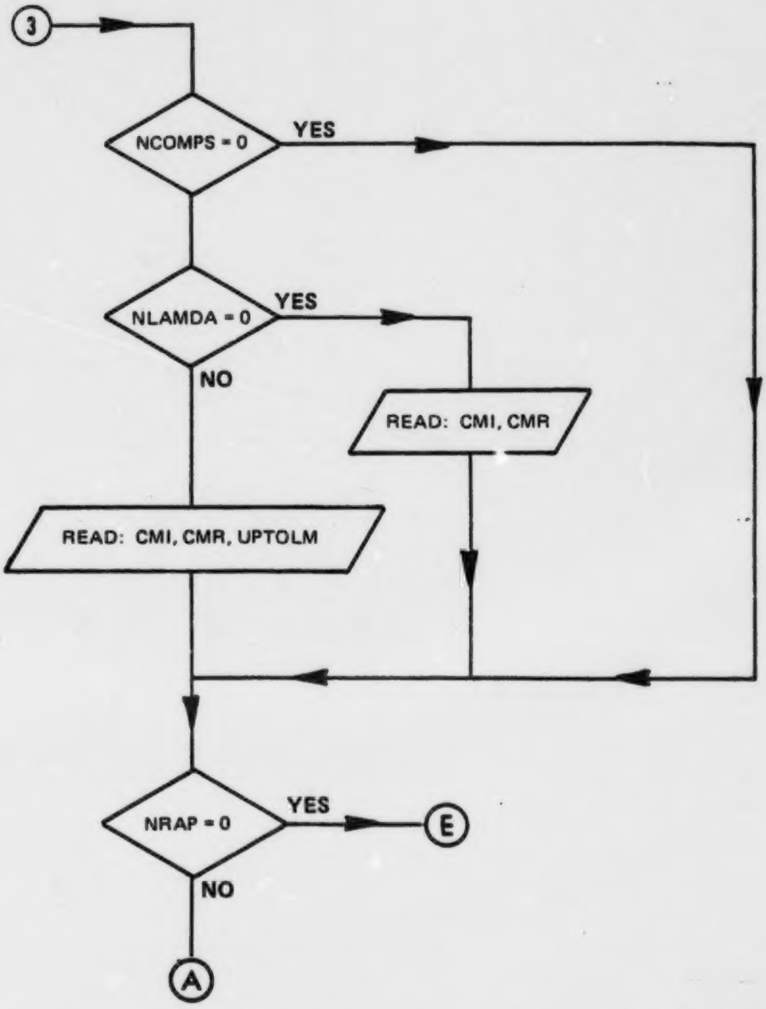
3
NCOMPS = 0
YES
NLAMDA = 0
YES
NO
READ: CMI, CMR
READ: CMI, CMR, UPTOLM
NRAP = 0
YES
E
NO
A

Figure 2. *Flow chart for the input data logic (Sheet 4 of 4).*

the first group of each data set and will also be the final card in the input data. If 21<NENDPT<99, the program will terminate abnormally during execution. NENDPT is read in with an I2 format and must be right justified in columns 1-2.

(2) NDATA is an indicator which tells the program to look for a certain type of data set. NDATA can have four possible values which will cause the program to look for the following data set types:

1 - A complete data set must be entered. NDATA must have this value on the first data set.

2 - Only cards 1 and 2 and data concerning size distribution information must be entered. All other data remain as defined in the previous data set. NDATA can have this value only after a basic data set has been run. This value of NDATA allows one to examine the effects of particle size distribution on precipitator performance with all other variables held fixed.

3 - Only cards 1 and 2 and information concerning the gas volume flow and gas velocity must be entered. All other data remain as defined in the previous data set. NDATA can have this value only after a basic data set has been run. This value of NDATA allows one to examine the effects of specific collection area (SCA) on precipitator performance with all other variables held fixed.

4 - Only cards 1 and 2 and information concerning the applied voltage and current must be entered. All other data remain as defined in the previous data set. NDATA can have this value only after a basic data set has been run. This value of NDATA allows one to examine the effects of the electrical conditions on precipitator performance with all other variables held fixed.

NDATA is read in with an I2 format and must be right justified in columns 3-4. If NDATA ≠ 1,2,3, or 4, an error message will be given by the computer at the point in the program where NDATA is used in a "computed go to statement". Depending on the particular computer, the program may or may not terminate at this point. If the program continues to execute, it may terminate abnormally at a later point in the program due to incorrect usage of the input data. If the program terminates normally, the calculations may or may not be correct, depending on the input data and the action taken by the computer.

(3) NRAP is an indicator which determines the type of rapping reentrainment correction which will be performed. If NRAP = 0, the correction is performed by the same empirical process used in the previous versions of this model. If NRAP = 1,2, or 3, a different process is used in which additional data are read into the program. From these data, the particle statistics of the reentrained dust are determined. The program then repeats the efficiency calculation for the input dust plus the reentrained dust, which is introduced into the gas flow at that point in the ESP at which it was rapped loose. The additional data required for dynamic rapping will be described later in this section. The values 1,2, or 3 determine the amount of ESP outlet information which is printed with 1 giving extensive details on individual particle statistics and 3 giving summaries only. These effects are described fully in the next section of this report. NRAP is read in with an I2 format and must be right justified in columns 5-6.

(4) MODL is an indicator which specifies the type of data to be read into the program and may have values from 0 to 3. If MODL = 0, mixed British and metric data are to be used. For MODL = 1, all data must be in metric units. If MODL = 2, an internal data set is used and the only other data required from the user is the resistivity of the input particles and the wire to plate spacing. This data set is described later in this section. For MODL = 3, the program terminates after printing the VI curves for the ESP. The options and data sets required when MODL = 3 are described in the subsection on unknown operating conditions. MODL is read in with an I2 format and must be right justified in columns 7-8.

(5) NOPRNT is an indicator which may have the values of 0 or 1. If NOPRNT = 0, the printed output includes data on particle charging and, if opacity is calculated, the differential extinction coefficient for each particle size band. If NOPRNT = 1, particle charging data is not printed and only total opacity figures are printed. NOPRNT is read in with an I2 format and must be right justified in columns 9-10.

(6) PATHL is the path length over which the opacity calculation will be made and is in units of ft or m. PATHL is read in with an F5.2 format in columns 11-15. If PATHL = 0.0, no opacity calculation is performed.

(7) NCOMPS is the number of indices of refraction for which the opacity is to be calculated. NCOMPS may have values from 0 to 10. If NCOMPS = 0 the two default values of the index of refraction are used. These are 1.50 + 0.0i and 1.50 - 0.10i. If NCOMPS = 1 to 10, the calculation is performed for the values which are read into the program. NCOMPS is read in with an I2 format and must be right justified in columns 19-20.

(8) NWAVES is the number of wavelengths at which opacity will be calculated and may have values of 0 or 1. If NWAVES = 0, the calculation is performed at 10 different points in the spectrum. If NWAVES = 1, the calculation will be performed at a wavelength of 0.55 μm only. NWAVES is read in with an I2 format and must be right justified in columns 24-25.

(9) NLAMDA is the number of indices of refraction which must be read in to perform the opacity calculation using an index of refraction that varies with wavelength. NLAMDA may have values from 0 to 10. If NLAMDA = 0, the index of refraction is assumed to be independent of wavelength and no extra data must be read in. If NLAMDA > 0, then NLAMDA indices of refraction and their associated wavelengths are read into the program. If NLAMDA > 0, NCOMPS must have a value of 1 or 2. If NCOMPS = 0, the value of NLAMDA is ignored. If NCOMPS > 2, and NLAMDA > 0, NCOMPS is set equal to 2. NLAMDA is read with an I2 format and must be right justified in columns 29-30.

The overall format for this group is (5I2, F5.2, 3(3X,I2)). The data contained in this group is on the first card and this card must be the first card in each new data set. However, only the first two parameters, NENDPT and NDATA, are required. The remaining seven parameters are optional. If only the first two parameters are given, the operation of the program is the same as for Revisions I and II except that execution is much faster. Consequently, data sets for the previous version of this model are still usable and will result in the same printed output as before. The use of the optional parameters will result in the inclusion of the extra processes described in the preceding parameter definitions. The last four parameters (PATHL, NCOMPS, NWAVES, and NLAMDA) define the opacity calculation and are interrelated as shown in Table 3.

Data group 2 is for specifying information which will identify the data set which is under consideration. All or part of columns 1-80 on data card 2 can be used in identifying the data set. The overall format for this card is (40A2). This data group must be the second card in each new data set.

At this point, the third and successive data groups depend on the choice of the value of NDATA. The basic data set must be read into the program before shortened data sets can be used. For NDATA=1, the program reads in the data groups in the basic data set in the sequence discussed below.

The following is a sequential listing of the variables in data group 3, along with the descriptions of the variables and the format specifications.

(1) NEST is an indicator which can have the values of 1 and 2. If NEST = 1, the program will perform extensive, detailed calculations in order to determine precipitator performance. If NEST = 2, estimation procedures are used to determine precipitator performance. Both of these options have been discussed in detail. Use of the estimation procedure will result in considerable savings in computer time and can be used to establish trends or to establish ranges over which to apply the more rigorous calculations. NEST is read in with an I2 format and must be right justified in columns 1-2.

(2) NDIST is an indicator which can have the values of 1 and 2. If NDIST = 1, the user must supply the inlet particle size distribution corresponding to the size bands specified by the variable ENDPT. If NDIST = 2, the program will construct a log-normal particle size distribution for these size bands based on the parameters D50 and SIGMAP. The technique used to construct the log-normal size distribution is described in Volume 1. NDIST is read in with an I2 format and must be right justified in columns 3-4.

(3) NVI is an indicator which can have the value 1 or 2. If NVI = 1, the user must supply known or measured values of the operating applied volate and current.

TABLE 3. OPACITY RELATED INPUT DATA

	VALUE OF	PARAMETER		
PATHL	NCOMPS	NWAVES	NLAMDA	CALCULATIONS PERFORMED
0.	--	--	--	No opacity calculation performed
>0	0	0	--	Opacity calculated at 10 wavelengths using default values of index of refraction
>0	0	1	--	Opacity calculated at 1 wavelength using default values of index of refraction
>0	1,2	0	0	Opacity calculated at 10 wavelengths using NCOMPS user supplied values of index of refraction
>0	1 to 10	1	0	Opacity calculated at 1 wavelength using NCOMPS user supplied values of index of refraction
>0	1,2	0	1 to 10	Opacity calculated at 10 wavelengths using NLAMDA user supplied values of frequency dependent index of refraction

If NVI = 2, the program will construct a voltage-current curve (or curves) for a specified wire-plate geometry up to a voltage which is specified by the user. Refer to the subsection on unknown operating conditions to determine when this option should be used. NVI is read in with an I2 format and must be right justified in columns 5-6.

(4) NX is the number of grid points in the x-direction (perpendicular to the gas flow) which is used in the numerical techniques that determine the electrical conditions. NX cannot exceed a value of 15. If NVI = 1, sufficient accuracy can normally be obtained with NX > 11. If NVI = 2, NX should be set equal to 15. NX is read in with an I2 format and must be right justified in columns 7-8.

(5) NY is the number of grid points in the y-direction (parallel to the gas flow) which is used in the numerical techniques that determine the electrical conditions. If NVI = 1, sufficient accuracy can normally be obtained with NY > 9. If NVI = 2, NY should be set equal to 15. NY is read in with an I2 format and must be right justified in columns 9-10.

(6) NITER is an indicator which serves two different purposes. If NVI = 1, the value of NITER determines the maximum number of iterations the program will make on a loop which converges on overall mass collection efficiency. If the overall mass collection efficiency converges within 0.05% before NITER iterations, the calculation of collection efficiencies is completed at this point. NITER serves the purpose of cutting the calculation off in a reasonable amount of time when convergence requires more iterations and computer time than is warranted. For normal inlet mass loadings and particle size distributions a value of NITER = 2 is sufficient. For high inlet mass loadings or very fine particle size distributions a value of NITER = 3 or 4 may be necessary to provide sufficient accuracy. If NVI = 2, the value of NITER determines the number of iterations which will be performed over each incremental length of the precipitator in order to obtain self-consistent solutions for the electrical conditions. In its present stage of development, the calculation procedure yields the same results for all values of NITER. Thus, in this case, set NITER = 1. The

calculation procedure is discussed in Appendix A of Volume 1. NITER is read in with an I2 format and must be right justified in columns 11-12.

(7) NCALC is an indicator which can have the values of 0 and 1. If NCALC = 0, particle charge is determined by using equation (12) in Volume 1. Due to the number of times particle charge must be calculated and the use of numerical techniques in order to solve the charging equation, the particle charging calculations for NCALC = 0 take a considerable amount of computer time. If NCALC = 1, particle charge is estimated empirically by using the sum of the charges predicted from classical field and thermal charging theories [see equation (15) in Volume 1]. In this case, particle charge can be determined very rapidly from analytical expressions. Thus, in those cases where a significantly shorter run time is more important than the best accuracy possible, NCALC should be set equal to 1. If NEST = 2, particle charge will be performed as if NCALC = 1 regardless of the value of NCALC. NCALC is read in with an I2 format and must be right justified in columns 13-14.

(8) NRAPD is an indicator which specifies the number of rapping puff particle size distributions which will be utilized by the program in predicting the effect of rapping reentrainment on overall mass collection efficiency. NRAPD must have a value of at least 1 and can not exceed a value of 10. If NRAPD = 1, the program will determine the rapping puff particle size distribution based on the average of data obtained from several field tests on full-scale precipitators. These tests yield an average rapping puff particle size distribution with a mass median diameter (MMD) of 6.0 μm and a geometric standard deviation (σ_p) of 2.5. The technique which is used to predict rapping losses is discussed in Volume 1. If NRAPD is greater than one, the user must supply a MMD and σ_p of a log-normal distribution corresponding to each value of NRAPD greater than 1. The program will determine the rapping puff particle size distribution based on the specified combinations of MMD and σ_p. The case for NRAPD = 1 will always be performed. Each rapping puff particle size distribution is used in conjunction with the same basic ideal calculation and its effect is determined with very little expenditure of computer time. NRAPD is read in with an I2 format and must be right justified in columns 15-16.

(9) NEFF	is an indicator which can have the values of 1 and 2. If NEFF = 1, the total mass reentrained at the outlet due to rapping is determined from the mass collected in the last field under adjusted no-rap conditions. If NEFF = 2, the total mass reentrained at the outlet due to rapping is determined from the mass which would be collected in the last field under unadjusted ideal conditions. NEFF should normally be taken to be 1 since this case is physically meaningful. A value of NEFF = 2 will result in rapping losses which are significantly greater than for NEFF = 1. Thus, a value of NEFF = 2 should only be used when a precipitator design which is conservative with respect to rapping losses is desired. NEFF is read in with an I2 format and must be right justified in columns 17-18.
(10) NTEMP	is an indicator which can have the values of 1 and 2. The mass reentrained due to rapping will differ for cold-side and hot-side precipitators. If NTEMP = 1, the mass reentrained due to rapping is estimated based on an equation for cold-side precipitators. If NTEMP = 2, the mass reentrained due to rapping is estimated based on equation for hot-side precipitators. NTEMP is read in with an I2 format and must be right justified in columns 19-20.
(11) NONID	is an indicator which specifies the number of combinations of normalized gas velocity standard deviation (σ_g) and gas bypassage fraction and/or particle reentrainment fraction without rapping (S) which are to be used to simulate the possible nonideal conditions. The procedures used to account for these nonideal effects are described in Volume 1. NONID must have a value of at least 1 and can not exceed a value of 15. Each set of nonideal conditions is used in conjunction with the same basic ideal calculation and its effect is determined with very little expenditure of computer time. NONID is read in with an I2 format and must be right justified in columns 21-22.

The overall format for this data group is (11I2) and all the data are contained on the third data card.

The next data group which is read in depends on the values of NCALC and NVI. If NCALC = 0, the rigorous charging theory is used. In this case, the following is a sequential listing of the variables in the next data group which is read in, along with the descriptions of the variables and the format specifications.

(1) NN is the number of increments in the Runge-Kutta integration of equation (12) in Volume 1. A value of NN = 5 will provide sufficient accuracy for normal use. Greater values found in data sets created for previous versions of the model may be used but will result in an increase in computer time for no appreciable increase in accuracy. NN is read in with an I2 format and must be right justified in columns 1-2.

(2) NUMINC was previously the number of increments in the Simpson's Rule integration over θ in equation (12) in Volume 1. Since this integration is now done by the Gaussian Quadrature method, this variable is no longer used. Data sets containing this variable may still be used, however, as the space allowed to NUMINC, columns 3-4, is not used for any other purpose.

The overall format for this data group is (I2) and all the data are contained on a single card. If NCALC = 1, the above data group is not read into the program.

If NVI = 2, the model must calculate a voltage-current curve. In this case, the following is a sequential listing of the variables in the next data group which is read in, along with the descriptions of the variables and the format specifications.

(1) IFINAL is an indicator which causes the calculation of successive points on the voltage-current curve to cease after IFINAL points. This indicator allows the user to have the V-I calculation terminated at a point before the specified operating voltage is reached whenever it is taking an excessive number of points to reach the specified operating voltage. IFINAL is read in with an I2 format and must be right justified in columns 1-2.

(2) JI1 is an indicator which allows the initial increment size on current density in the calculation of the voltage-current curve to be changed after JI1-1 points are determined on the curve. Since the voltage-current calculation finds the applied voltage corresponding to a specified value of current density, this indicator allows the user to cover a large range of current densities without using an excessive number of points. JI1 is read in with an I2 format and must be right justified in columns 3-4.

(3) JI2 is an indicator which allows the second increment size on current density in the calculation of the voltage-current curve to be changed after JI2-1 points are determined on the curve. JI2 serves the same function as JI1 and JI2 must have a value greater than JI1 for proper usage. JI2 is read in with an I2 format and must be right justified in columns 5-6.

(4) VISKIP is an indicator which may have the values of 0 and 1. If VISKIP = 0, a voltage-current curve will be calculated up to a specified operating voltage for each successive length increment of the precipitator. If VISKIP = 1, only the operating current density which corresponds to a specified operating voltage will be calculated based on an estimation procedure discussed in Volume 1. In most cases, the user will want to set VISKIP = 1 since this will result in a prediction of the operating current density in each increment of length of the precipitator without using the large amounts of computer time required by the calculation of a voltage-current curve. Only extremely detailed analysis would warrant setting VISKIP = 0. VISKIP is read in with an I2 format and must be right justified in columns 7-8.

(5) VISAME is an indicator which may have the values of 1 and 2. The proper use of VISAME can result in significant savings in computer time whenever the applied voltage is the same in each electrical section. If the applied voltage is the same in each electrical section, set VISAME = 1 and only one "clean" voltage-current curve will be calculated. If VISAME = 1, as many data sets as desired can be read into the program and all calculations will be based on the one "clean" voltage-current calculation. The use of VISAME = 1 is especially beneficial in studying hypothetical cases due to the large savings in computer time. If the applied voltage differs from one electrical section to the next, the user must set VISAME = 2. Whenever the operating voltage and current are unknown and the user must specify the use of the voltage-current calculations (NVI = 2), the quickest run time will occur when VISKIP = 1 and VISAME = 1. The longest run time will occur when VISKIP = 0 and VISAME = 2. VISAME is read in with an I2 format and must be right justified in columns 9-10.

The overall format for this data group is (5I2) and all data are contained on single card. If NVI = 1, the above data group is not read into the program.

The following is a sequential listing of the next data group which is read in, along with the descriptions of the variables and the format specifications.

(1) DL — is the inlet particulate mass loading in units of grains/ft^3 or kg/m^3. DL is read in with a F8.0 format and must be left justified in columns 1-8.

(2) PL — is the total electrical length of the precipitator in units of ft or m. PL is read in with a F8.0 format and must be left justified in columns 9-16.

(3) ETAO — is the overall mass collection efficiency in units of percent and it has two different interpretations depending upon the value of NVI. If NVI = 1, ETAO represents the measured or estimated overall mass collection efficiency and is used as a test for convergence in an iteration loop on overall mass collection efficiency. If NVI = 2, ETAO simply represents the desired design efficiency and is not used in the calculations. ETAO is read in with a F8.0 format and must be left justified in columns 17-24.

(4) DD — is the density of the particles in units of kg/m^3. DD is read in with a F8.0 format and must be left justified in columns 25-32.

(5) EPS — is the dielectric constant of the particles for use in the particle charging calculations and is dimensionless. Values of EPS must be equal to or greater than 1. In most industrial applications, the flue gas is sufficiently humidified that the particle surface becomes conductive and a value of EPS = 100 can be used to simulate a conductor. EPS is read in with a F8.0 format and must be left justified in columns 33-40.

(6) VRATIO — is the ratio of the peak voltage to the average voltage and is dimensionless. In the calculation of particle charge, it is assumed that the particles will charge to an extent determined by the peak voltage rather than the average voltage. For industrial applications, VRATIO has a value around 1.2. VRATIO is read in with a F8.0 format and must be left justified in columns 41-48.

(7) US is the ionic mobility at standard temperature (273°K) and standard pressure (1 atm) and is in units of $m^2/(V\text{-}sec)$. This mobility is referred to as the "reduced mobility". Values to use for reduced ionic mobilities for flue gas compositions are not well-established at the present time. The reduced ionic mobility for air is in the range 1.2-2.1 x $10^{-4} m^2/(V\text{-}sec)$. Reduced ionic mobilities for flue gas compositions have been reported that are considerably larger than those reported for air. These values cover the range of 2.2-5.4 x $10^{-4} m^2/(V\text{-}sec)$. Some reported values of reduced ionic mobility for various gas compositions are given in Table 1. Since the ionic mobility has a strong influence on the electrical conditions through the current and electric field distributions, this is an important parameter in determining precipitator performance. A value of 2.7 x $10^{-4} m^2/(V\text{-}sec)$ should provide a representative value to use for flue gases emanating from coal-fired boiler applications. US is read in with a F8.0 format and must be left justified in columns 49-56.

(8) FPATH is a parameter which is used in the field charging equation and is dimensionless. FPATH represents the number of ionic mean free paths over which the momentum of the ions will persist and allow the ions to reach the surface of the particle even though the saturation charge has been reached. The effect of this parameter is to increase the saturation charge. FPATH normally should have a value in the range 0-2. It is recommended that FPATH be assigned a value of 1. FPATH is read in with a F8.0 format and must be left justified in columns 57-64.

(9) EBD is the electrical breakdown strength of the gas or the particulate layer in the region near the plate and is in units of V/m. The value of this parameter is a strong function of the resistivity of the collected particulate layer and the condition of the collection plates. At present, mathematical techniques which are based on physical principles do not exist for predicting the value of EBD under differing conditions. Thus, experimental data and prior experience must be used to choose appropriate values of EBD. In practical applications, EBD falls in the range of 2-15 kV/cm. A value of 2 kV/cm should provide a conservative estimate of EBD whereas a value of 15 kV/cm would

in most cases provide the most optimistic value. The value of EBD is used whenever NVI = 2 and a voltage-current curve is generated. If the field at the plate exceeds the value of EBD at any point on the curve, a message to this effect is printed out with the V-I calculation terminating at the corresponding applied voltage and current density. These values of voltage and current are then used in the projection of precipitator performance. EBD is read in with a F8.0 format and must be right justified in columns 65-72.

(10) RHO is the resistivity of the collected particulate layer and is in units of ohm-cm. The resistivity to be used must be determined experimentally by either in situ or laboratory methods. RHO is used in the model only if the operating conditions are unknown. For this use refer to the subsection on unknown operating conditions. RHO is read in with an 8.2 format and must be right justified in columns 73-80.

> When the operating voltages and current are specified, the value of RHO has no effect on the operating conditions. To estimate the effects of a change in RHO, the procedures listed under unknown operating conditions must be used.

The above data group has an overall format of (9F8.0, E8.2) and is contained on a single data card. This data set must be read in with each basic data set, i.e. when NDATA = 1.

The next data group which is read in depends on the value of NRAPD. If NRAPD is greater than 1, the following is a sequential listing of the variables in the next data group, along with the descriptions of the variables and the format specifications.

(1) ARD50(I) is an array containing the mass median diameters in μm for log-normal particle size distributions of the different rapping puff distributions which will be utilized in the model. The values of this variable are read in with a F4.0 format and must be left justified in columns 1-4, 9-12, 17-20, 25-28, 33-36, 41-44, 49-52, 57-60, 65-68, and 73-76.

(2) ARSIGM(I) is an array containing the geometric standard deviations for log-normal particle size distributions of the different rapping puff distributions which will be utilized in the model.

Values of ARD50(I) and ARSIGM(I) with the same index are used together to construct a log-normal particle size distribution. The values of this variable are read in with a F4.0 format and must be left justified in columns 5-8, 13-16, 21-14, 29-32, 37-40, 45-48, 53-56, 61-64, 69-72, and 77-80. ARSIGM(I) can not have a value less than 1.

The above variables must be read in for I=2 up to I=NRAPD where NRAPD can not exceed a value of 10. The overall format for this data group is (10(2F4.0)) and is contained on a single data card. If NRAPD=1, this data group is not read in. In this case, only one rapping puff particle size distribution will be considered where ARD50(1) = 6.0 in μm and ARSIGM(1) = 2.5. This case is built into the program and relates to experimental data discussed in Volume 1.

The following is a sequential listing of the variables in the next data group which is read in, along with the descriptions of the variables and the format specifications.

(1) ASNUCK(I) is an array containing different fractions of gas flow which bypass the electrified region in each baffled stage of the precipitator and/or different fractions of the mass collected in each stage of the precipitator which are reentrained due to factors other than rapping. The values of this variable are read in with a F4.0 format and must be left justified in columns 1-4, 13-16, 25-28, 37-40, 49-52, and 61-64 of the first two data cards in the group and in columns 1-4, 13-16, and 25-28 of the third data card in the group. ASNUCK(I) must lie in the range 0.0 to 1.0.

(2) AZIGGY(I) is an array containing different normalized standard deviations for the inlet velocity distribution of the gas flow. The values of this variable are read in with a F4.0 format and must be left justified in columns 5-8, 17-20, 29-32, 41-44, 53-56, and 65-68 of the first two data cards in the group and in columns 5-8, 17-20, and 29-32 of the third data card in the group. AZIGGY(I) must be equal to or greater than 0.0.

(3) AZNUMS(I) is an array containing the number of baffled stages in the precipitator. The values of this variable are read in with a F4.0 format and must be left justified in columns 9-12, 21-24, 33-36, 45-48, 57-60, and 69-72 of the first two data cards in the group and in columns 9-12, 21-24, and 33-36 of the third data card in the group. The values of AZNUMS(I) must be whole numbers.

The values of ASNUCK(I), AZIGGY(I), and AZNUMS(I) with the same index are used together to simulate one set of nonideal parameters and to produce one set of no-rap efficiencies. The values of I are determined by NONID which must have a value of at least 1 and can not exceed a value of 15. Thus, at least one set of these parameters must be read in. It is recommended that the user take the first set of these variables to be ASNUCK(1) = 0.00, AZIGGY(1) = 0.00, and AZNUMS(1) = actual number of stages so that efficiencies under ideal conditions will be obtained. In practical situations, a well-operating precipitator will have values of ASNUCK and AZIGGY of approximately 0.1 and 0.25, respectively.

The overall format for this data group is (6(3F4.0)) and the data group is contained on 3 or less cards. For NONID < 6, 6<NONID < 12, and 12<NONID < 15, the number of data cards necessary are 1, 2, and 3, respectively. This data group must be read in with each basic data set.

The next data group which is read in consists of a single array. The description of this array and its format specification are given below.

(1) ENDPT(I) is an array containing values of particle diameters corresponding to points on a curve of inlet mass cumulative percent versus particle diameter. The number of diameters read in must equal the value of NENDPT which can not exceed a value of 21. The diameters must be entered in order from smallest to largest in units of μm. The smallest diameter can not be less than 0.01 μm and the largest diameter can not exceed 1,000 μm. These diameters are used to construct particle size intervals and a particle size histogram. The midpoints between successive particle diameters constitute NENDPT-1 average particle diameters which are used in the program to characterize the different particle size bands. In constructing the particle diameters to be used in the calculations, it is recommended that greater resolution be built into the fine particle size range of 0.1-3.0 μm since the lower efficiencies are obtained in this size range. The values of ENDPT(I) are read in with a F8.0 format and must be left justified.

The overall format for this data group is (10F8.0) and the data group is contained on 3 or less data cards. For NENDPT < 10, 10<NENDPT < 20, and NENDPT = 21, the number of data cards necessary are 1, 2, and 3, respectively. This data group must be read in with each basic data set.

The next data group which is read in depends on the value of NDIST. If NDIST = 2, the following is a sequential listing of the variables in the next data group, along with the descriptions of the variables and the format specifications.

(1) D50 is the mass median diameter of a log-normal inlet particle size distribution and is in units of µm. The value of D50 must lie between 0.01 and 1,000 µm. The value of D50 is read in with a F8.0 format and must be left justified in columns 1-8.

(2) SIGMAP is the geometric standard deviation of a log-normal inlet particle size distribution and is dimensionless. The value of SIGMAP must be equal to or greater than 1. The value of SIGMAP is read in with a F8.0 format and must be left justified in columns 9-16.

The program uses the values of D50 and SIGMAP to construct a log-normal particle size distribution over the range and size bands determined by the values of ENDPT(I). Any mass which is not in the size range determined by ENDPT(I) will be put into the size band with the largest midpoint. This must be done to ensure that the sum over all size bands of the percentage of total mass in each size band will equal 100%.

The above data group has an overall format of (2F8.0) and is contained on a single data card. This data set is not read in if NDIST = 1.

If NDIST = 1, the next data group which is read in consists of a single array. The description of this array and its format specification are given below.

(1) PRCU(I) is an array containing values of cumulative percents corresponding to points on a curve of inlet mass cumulative percent versus particle diameter. The number of cumulative percents read in must equal the value of NENDPT which can not exceed 21. The cumulative percents must match the particle diameters specified in the array ENDPT(I). The cumulative percents are entered in units of %. The first value of PRCU(I) must be 0% and the last value must be 100%. The program determines the percentage by mass in each particle size band from the values contained in ENDPT(I) and PRCU(I). The user must supply values of PRCU(I) based on measured or known particle size information for the particular application under consideration. The values of PRCU(I) are read in with a F8.0 format and must be left justified.

The overall format for this data group is (10F8.0) and the data group is contained on 3 or less data cards. For NENDPT < 10, 10<NENDPT < 20, and NENDPT = 21, the number of data cards necessary are 1, 2, and 3, respectively. This data group is not read in if NDIST = 2.

The following is a sequential listing of the variables in the next data group which is read in, along with the descriptions of the variables and the format specifications.

(1) NUMSEC is the number of electrical sections in the direction of gas flow. The maximum number of electrical sections which can be accounted for in the program listed in Volume 1 is 10. The value of this variable is red in with an I2 format and must be right justified in columns 1-2.

(2) LSECT(I) is an array containing values of the number of incremental lengths to be taken in each electrical section in the direction of gas flow. These values are determined by the user with increasing values of I corresponding to electrical sections moving from the inlet to the outlet of the precipitator. The total number of incremental lengths in all sections must not exceed 99. It is not necessary to have the same number in each section. The values of this variable are read in with an I2 format and must be right justified.

The overall format for this data group is (I2, 10I2) and the data group is contained on a single data card. This data group must be read in with each basic data set.

The following is a sequential listing of the variables in the next data group which is read in, along with the descriptions of the variables and the format specifications.

(1) AS(NSECT) is the total collection plate area for a given electrical section and is in units of ft^2 or m^2. The values of this variable are read in with an E11.4 format and must be right justified in columns 1-11.

(2) VOS(NSECT) is the applied voltage in a given electrical section and is in units of volts. If NVI = 1, the value of VOS(NSECT) corresponds to a measured or known value. If NVI = 2, VOS(NSECT) corresponds to an applied voltage up to which a voltage-current curve will be calculated. Then, this applied voltage along with the corresponding current will

be used in the calculation of precipitator performance. The values of this variable are read in with an E11.4 format and must be right justified in columns 12-22.

(3) TCS(NSECT) is the total current in a given electrical section and is in units of amperes. If NVI = 1, the value of TCS(NSECT) corresponds to a measured or known value. If NVI = 2, TCS(NSECT) has no meaning in terms of input data since it will be calculated in the program. In this case, the appropriate columns on the data card can be left blank or any arbitrary number can be entered. The values of this variable are read in with an E11.4 format and must be right justified in columns 23-33.

(4) WLS(NSECT) is the total effective wire length in a given electrical section and is in units of ft or m. The values of this variable are read in with an E11.4 format and must be right justified in columns 34-44.

(5) ACS(NSECT) is the corona wire radius in a given electrical section and is in units of in. or mm. The values of this variable are read in with an E11.4 format and must be right justified in columns 45-55.

(6) BS(NSECT) is the wire-to-plate spacing in a given electrical section and is in units of in. or m. The values of this variable are read in with an E11.4 format and must be right justified in columns 56-66.

(7) NWS(NSECT) is the number of discharge electrodes per given electrical section per gas passage and is dimensionless. The values of this variable normally should not exceed 20. If the values do exceed 20, use 20 in the program. These values are used to determine the number of terms in a series summation which determines the electrostatic electric field distribution and 20 terms are more than sufficient to reach convergence. The values of this variable are read in with an E11.4 format and must be right justified in columns 67-77.

(8) SYS(NSECT) is one-half of the wire-to-wire spacing in a given electrical section and is in units of in. or m. The values of this variable are read in with an E11.4 format and must be right justified in columns 1-11.

(9) VGS(NSECT) is the total gas volume flow rate in a given electrical section and is in units of actual ft^3/min or m^3/sec. The values of this variable are read in with an E11.4 format and must be right justified in columns 12-22.

(10) VGASS(NSECT) is the gas velocity in a given electrical section and is in units of ft/sec or m/sec. The values of this variable are read in with an E11.4 format and must be right justified in columns 23-33. The gas velocity must be consistent with the gas volume flow rate and the precipitator geometry in each electrical section. These are related by

VGASS(I) = (LINCS(I)*LSECT(I)*VGS(I))/(AS(I)*BS(I)*Constant),

where the constant = 1 for metric units and 5 for English units.

(11) TEMPS(NSECT) is the gas temperature in a given electrical section and is in units of °F or °C. The values of this variable are read in with an E11.4 format and must be right justified in columns 34-44.

(12) PS(NECT) is the gas pressure in a given electrical section and is in units of atmospheres. The values of this variable are read in with an E11.4 format and must be right justified in columns 45-55.

(13) VISS(NSECT) is the gas viscosity in a given electrical section and is in units of kg/(m-sec). Table 2 gives values of viscosity for different temperatures and water contents for a gas composition whose components are those of air. This table provides values of viscosity which cover most cases found in practice although some extrapolation is necessary for those cases involving hot precipitators where temperatures are greater than 300°C. The values of this variable are read in with an E11.4 format and must be right justified in columns 56-66.

(14) LINCS(NSECT) is the incremental length size which will be taken in a given electrical section and is in units of ft or m. If NVI = 1, LINCS(NSECT) should be given a value of approximately one foot although larger values can be used with some loss in accuracy in order to save computer run time. If NVI = 2, LINCS(NSECT) must be given a value equal as near as possible to the wire-to-wire spacing in order for the numerical procedure to be valid. In any case, the product of LSECT(NSECT) and

LINCS(NSECT) must equal the total length of the given electrical section. The values of this variable are read in with an E11.4 format and must be right justified in columns 67-77.

The overall format for this data group is (7(E11.4)) and the data group is contained on two data cards. This data group must be read in with each basic data set.

The next data group which is read in depends on the value of NVI. If NVI = 2, the following is a sequential listing of the variables in the next data group which is read in, along with the descriptions of the variables and the format specifications.

(1) RFS(NSECT) is the roughness factor for the wires in a given electrical section and is dimensionless. In precipitation practice, if the wires are scratched or dirty but not completely coated with air, then the values of RFS(NSECT) lie in the range 0.5-1.0. A value of 1.0 corresponds to wires which are in perfect condition. The effect of decreasing the roughness factor is one of increasing the current that can be achieved at a given voltage level. If the wires are completely covered with dirt, then the effect may be one of increased wire diameter with a roughness superimposed. This situation would lead to compensating effects. The values of this variable are read in with an E11.4 format and must be right justified in columns 1-11.

(2) START1(NSECT) is the chosen initial current density at which the calculation of a voltage-current curve starts in a given electrical section and is in units of A/m^2. In generating the voltage-current curve, the current density increments in steps of START1 (NSECT) until a change is specified. The values of this variable are read in with an E11.4 format and must be right justified in columns 12-22.

(3) START2(NSECT) is a chosen increment in current density which is used in place of START1(NSECT) when the JI1-th point on the voltage-current curve is reached and is in units of A/m^2. The values of this variable are read in with an E11.4 format and must be right justified in columns 23-33.

(4) START3(NSECT) is a chosen increment in current density which is used in place of START2(NSECT) when the JI2-th point on the voltage-current curve is reached and is in units of A/m^2. The values of this variable

are read in with an E11.4 format and must be right justified in columns 34-44.

(5) *VSTAR(NSECT)* is an estimate of the applied voltage corresponding to the first point on the voltage-current curve as defined by START1(NSECT) and is in units of volts. If VSTAR(NSECT) is close to the actual applied voltage, the calculation will be performed faster. However, whatever the choice of VSTAR(NSECT), it will not affect the accuracy of the calculation. The values of this variable are read in with an E11.4 format and must be right justified in columns 45-55.

The overall format for this data group is (7(E11.4)) and the data group is contained on a single data card. *If NVI = 1, this data group is not read in.*

The data input starting with AS(NSECT) above must be repeated for each electrical section of the precipitator, proceeding from the inlet to the outlet of the precipitator. Thus, the data group containing AS(NSECT) and possibly the data group containing RFS(NSECT) must be read in NUMSEC different times.

At this point, the basic data set has been entered into the program and precipitator performance will be projected based on this data. The last card in the data section must have a 99 in columns 1-2. This causes the program to terminate normally.

CONSTRUCTION OF SHORTENED DATA SETS

Once the basic data set is processed, then all the parameters which are needed by the program to calculate precipitator performance are stored in memory. By using values of NDATA equal to 2, 3, or 4, shortened data sets can be entered after the basic data set in order to analyze the effects of particle size distribution, specific collection area, and electrical conditions on precipitator performance. In the shortened data sets, the values of a small number of variables which are stored in memory are changed to new values in order to produce a new set of data.

In each shortened data set, the first two data groups and data cards which are read in are the same as those discussed for the basic data set. The value of NDATA on the first data card determines the variables in memory that will be changed. The effects of particle size distribution on precipitator performance can be analyzed by setting NDATA = 2. In this case, the third data group which is read in depends upon the value of NDIST which is stored in memory. If NDIST = 2, an inlet mass median diameter (D50) and geometric standard deviation (SIGMAP) must be read in according to the same specifications discussed for the basic data set. If NDIST = 1, cumulative percents (PRCU(I)) corresponding to the particle sizes (ENDPT(I)) stored in memory must be read in according to the same specifications discussed for the basic data set. After the third data group is read in, the shortened data set is complete. By repeating this type of shortened data with different choices of D50 and SIGMAP or PRCU(I), the effects of particle size distribution can be analyzed with the use of only a few data cards.

The effects of specific collection area (SCA) on precipitator performance can be analyzed by setting NDATA = 3. In this case, the following is a sequential listing of the variables which are inputted in the third data group, along with the descriptions of the variables and the format specifications.

(1) VGS(I) is the total gas volume flow rate in a given electrical section and is in units of actual ft^3/min. The values of this variable are read in with an E11.4 format and must be right justified in columns 1-11, 23-33, and 45-55.

(2) VGASS(I) is the gas velocity in a given electrical section and is in units of ft/sec. The values of this variable are read in with an E11.4 format and must be right justified in columns 12-22, 34-44, and 56-66.

There must be a value of VGS(I) and VGASS(I) entered for each electrical section. The overall format for this data group is (3(2E11.4)) and the data group is contained on 4 or less cards depending on the value of NUMSEC which is stored in memory. For NUMSEC $\leq$ 3, 3<NUMSEC $\leq$ 6, 6<NUMSEC $\leq$ 9, and NUMSEC = 10, the number of data cards necessary are 1, 2, 3, and 4, respectively.

After this data group is read in, the shortened data set is complete. By repeating this type of shortened data set with different choices of VGS(I) and VGASS(I), the effects of specific collection area can be analyzed with the use of only a few data cards.

The effects of applied voltage and current on precipitator performance can be analyzed by setting NDATA = 4. In this case, the following is a sequential listing of the variables which are inputted in the third data group, along with the descriptions of the variables and the format specifications.

(1) VOS(I) is the applied voltage in a given electrical section and is in units of volts. If the value of NVI stored in memory is 1, the value of VOS(I)

corresponds to a measured or known value. If the value of NVI stored in memory is 2, VOS(I) corresponds to an applied voltage up to which a voltage-current curve will be calculated. Then, this applied voltage along with the corresponding current will be used in the calculation of precipitator performance. The values of this variable are read in with an E11.4 format and must be right justified in columns 1-11, 23-33, and 45-55.

(2) TCS(I) is the total current in a given electrical section and is in units of amperes. If the value of NVI stored in memory is 1, TCS(I) corresponds to a measured or known value. If the value of NVI stored in memory is 2, TCS(I) has no meaning in terms of input data since it will be calculated in the program. In this case, the appropriate columns on the data cards can be left blank or any arbitrary number can be enetered. The values of this variable are read in with an E11.4 format and must be right justified in columns 12-22, 34-44, and 56-66.

There must be a value of VOS(I) and TCS(I) entered for each electrical section. The overall format for this data group is (3(2E11.4)) and the data group is contained on 4 or less cards depending on the value of NUMSEC which is stored in memory. For NUMSEC $<$ 3, 3$<$NUMSEC $<$ 6, 6$<$NUMSEC $<$ 9, and NUMSEC = 10, the number of data cards necessary are 1, 2, 3, and 4, respectively.

After this data group is read in, the shortened data set is complete. By repeating this type of shortened data set with different choices of VOS(I) and TCS(I), the effects of voltage and current can be analyzed with the use of only a few data cards.

DYNAMIC RAPPING DATA SET

If NRAP $\neq$ 0 on the first data card, then additional data will need to be read into the program for the dynamic rapping process. This data, which is defined below, follows the basic data set. The maximum number of incremental lengths is limited to 45 when dynamic rapping is used.

(1) TIMRAP is the time at which a rap occurs. This variable is read in with an F10.5 format in columns 1-10. TIMRAP is specified in minutes.

(2) MAPRAP(I) is an indicator which specifies which increments of the precipitator are included in the rap. (These increments are the same calculation increments

defined by the variable LSECT in the basic data set.) Since the maximum number of increments is 45, MAPRAP is read in with a 45I1 format. If TIMRAP > 0 and MAPRAP(I) > 0, then the Ith increment of the precipitator is defined as having been rapped. The program sets the dust thickness on the collection plate at increment I equal to 0 and stores a portion of the collected dust for reintroduction into the gas flow at that point. If TIMRAP > 0 and MAPRAP(I) = 0, then the Ith increment was not rapped. If TIMRAP = 0 and MAPRAP(1) ≠ 0, the program will treat the next card as the beginning of an all new rapping scheme. In this case, the next card read in will be the first TIMRAP card of the new scheme. If TIMRAP = 0 and MAPRAP(1) = 0, the rapping calculation is terminated and the program resumes normal operation. The next card that will be read in this case is card 1 of the basic data set. MAPRAP is located in columns 11-55.

(3) REPCT is the fraction of the dust collected in one electrical section that is reentrained during the time required for the gas to flow past one computational length increment, LINCS. This is defined by

$$\mathrm{REPCT} = \frac{\mathrm{F}}{\mathrm{NLANES}} * \frac{\text{Duration of gas flow past one increment}}{\text{Total duration of each rapping puff}},$$

where F is the total fraction of the collected dust that will be reentrained during a rap and NLANES is the number of parallel lanes in the section which are rapped at different times.

(4) NUMBOL is the number of data points in the reentrainment profile. NUMBOL is read in with an I2 format and must be right justified in columns 61-65.

(5) NDAT is an indicator which can assume the values of 0 or 1. If NDAT = 1, the subsequent cards will define the rapping profile. If NDAT = 0, the existing rapping profile will be used in this rap. NDAT is read in with an I5 format and must be right justified in columns 66-70.

The overall format for this card is (F10.5, 45I1, F5.3, 2I5). This card is used to define each rap of the precipitator. If two or more sections of the precipitator are rapped at the same time, a single card can contain all of the necessary information. However, any rap which occurs at a different time will require another TIMRAP card.

If NDAT = 1 on the TIMRAP card, the following cards must be inserted following that card to define the rapping profile:

(1) BOLFRC(I,J) are the data points used to construct the normalized histogram of fractions of dust reentrained in a given time interval. There must be NUMBOL values of BOLFRC on the card. BOLFRC is read into the program with an F6.3 format.

The overal format of this card is (13F6.3). The program expects the number of BOLFRC cards to equal the number of precipitator sections (NUMSEC) so that a different reentrainment histogram may be read in for each section. After NUMSEC cards are read, the following data is expected:

(1) REMMD(I,J) are the mass median diameters for a log-normal size distribution associated with each step of the histrogram defined by BOLFRC(I,J). There must be NUMBOL values of REMMD on the card. REMMD is read with an F6.3 format and must be in units of μm.

(2) RESIG(J) is the geometric standard deviation of the log-normal size distributions defined by REMMD. The value of RESIG must be equal to or greater than 1. RESIG is read in an F6.3 format immediately following the last value of REMMD(I,J).

The overall format of this card is (13F6.3). The program expects to read NUMSEC REMMD cards to match the NUMSEC BOLFRC cards. After these cards are used, the following card is read in:

(1) BOLTIM(I) are the durations in seconds of each of the steps of the rapping histogram. The sum of the values of BOLTIM(I) is the total duration of the rapping emissions and must obey the following relation:

$$\Sigma \text{ Boltim(I)} = \text{NLANES*Total duration of each rapping puff}$$

The total duration of the rapping emissions must not exceed the time between raps as the model cannot correct for overlapping rapping puffs. There must be NUMBOL values of BOLTIM on the card in an F6.3 format.

(2) DDRAP is the particle density of the reentrained dust. DD rap is in units of kg/m^3 and is read in with an F6.3 format.

The overall format of this card is (13F6.3). Only 1 BOLTIM card will be read in as the durations of the steps in the histogram are assumed to be the same for all sections of the precipitator. The rapping profile must be read in after the first TIMRAP card. Thereafter, it may be read in if it is changed. After the BOLTIM card is read in, the next card expected by the program is a new TIMRAP card.

OPACITY DATA SET

In the calculation of precipitator outlet opacity, additional data is required if NCOMPS is greater than 0. If NCOMPS > 0 and NLAMDA = 0, user supplied values of the read and imaginary parts of the index of refraction must be read into the program:

(1) CMR(I) is the real part of the user supplied index of refraction. This quantity is read in with an F5.3 format.

(2) CMI(I) is the imaginery part of the user supplied index of refraction. CMI(I) is read with an F5.3 format.

The NCOMPS values of CMR(I) and CMI(I) are read in as data pairs with an overall format of (6(2F5.3)).

If NCOMPS > 0 and NLAMDA > 0, then the index of refraction changes with wavelength. In this case the following data are read in:

(1) CMR(J) is the real part of the user supplied index of refraction for wavelengths ranging from the value of UPTOLM(J-1) (assumed to be 0.43 µm if J = 1) to the value of UPTOLM(J). CMR is read in with an F5.3 format.

(2) CMI(J) is the imaginary part of the user supplied index of refraction for wavelengths ranging from the value of UPTOLM(J-1) to the value of UPTOLM(J). CMI is read in with an F5.3 format.

(3) UPTOLM(J) is the upper limit of the wavelength band for which CMR(J) and CMI(J) are the correct indices of refraction. UPTOLM is in units of µm and is read in with an F5.3 format. The final value of UPTOLM(J) must be equal to or greater than 0.70.

The NLAMDA values of CMR(J), CMI(J), and UPTOLM(J) are read in the form of data groups, each complete for a given value of J. The overall format for this data is (4(3F5.2)).

UNKNOWN OPERATING CONDITIONS

The model may be used to calculate V-I curves and collection efficiencies for precipitators with unknown operating voltages and currents. Table 4 summarizes the options available to the user and makes recommendations on the applicability of each. If collection efficiency data for a utililty fly ash precipitator is desired, the following data set should be used.

The first data card has the same format as the first card in the basic data set. MODL must be set to 2 in column 8. Since the remainder of the data in this data group is redefined in subroutine INTERN, the rest of the card may be left blank if desired.

Data group 2 contains the following 2 data.

(1) RHO	is the resistivity of the collected particulate layer expressed in ohm-cm. RHO is entered with an E8.2 format and must be right justified in columns 1-8.
(2) HDUCT	is the wire-to-plate spacing in units of inches. HDUCT is read with an F5.2 format in columns 11-15.

If the ESP being studied is similar to a utility fly ash precipitator, the above procedure may be used. However, if the ESP is much different from a utility fly ash precipitator, a different procedure should be used. This procedure is enabled when NVI is set to 2 in data group 3. The description of the data required for this case is contained in the discussion of the basic data set.

If only V-I curves are desired, the required data set again depends on whether the ESP is similar to a utility fly ash precipitator. If the ESP is similar, then the first 3 data groups are the same as for the basic data set described earlier in this section. To get the V-I calculation, the following values must appear:

(1) Card 1: MODL = 3 in column 8 (the rest of the card may be blank),

(2) Card 3: NVI = 1 in column 6 (the rest of the card may be blank).

Table 4. User options when the operating voltage and current are not known

Desired Calculation	Variables				Procedure Recommended	Comments
	MODL	NVI	VISKIP	VISAME		
Collection efficiency of a utility fly ash precipitator.	2	1	n/a	n/a	Yes	Uses internal data set based on 17 field tests of cold-side utility fly ash precipitators to generate efficiencies for a range of SCA values. Fast.
	0 or 1	2	1	1 or 2	No	Calculates approximate V-I curves; then calcules efficiency for a derived operating point. Slow. VISAME=2 (different voltages in each section) is slower than VISAME=1 (same voltage).
Collection efficiency for an ESP that is much different from a utility fly ash ESP.	2	1	n/a	n/a	No	Precipitator test data used in internal data set are not similar to this application. Accuracy may be low. Fast.
	0 or 1	2	1	1	Yes	Calculates approximate V-I curves; then calculates efficiency for a derived operating point. Uses the same operating point in each ESP section. Slow.
	0 or 1	2	1	2	No	Same as above except calculates a new operating point for each ESP section. Slower.
	0 or 1	2	0	2	No	Same as above except calculates electric fields and potentials in each ESP length increment. Very slow.

Table 4. (Continued)

Desired Calculation	Variables				Procedure Recommended	Comments
	MODL	NVI	VISKIP	VISAME		
V-I curves only for a utility fly ash precipitator.	3	1	n/a	n/a	Yes	Uses internal data set to generate V-I curves. No efficiency calculated. Fast.
	3	2	1	1 or 2	No	Calculates V-I curve for first section only using approximate procedures. No efficiency calculated. Slow
V-I curves only for an ESP that is much different from a utility fly ash ESP.	3	1	n/a	n/a	No	Uses internal data set to generate V-I curves. Precipitator test data used in internal data set are not similar to this application. Accuracy may be low. Fast.
	3	2	1	1 or 2	Yes	Calculates V-I curve for first section only using approximate procedures. No efficiency calculated. Slower.

Card 4 will contain the following data:

(1) RHO is the resistivity of the collected particulate layer expressed in ohm-cm. RHO is entered with an E8.2 format and must be right justified in columns 1-8.

(2) HDUCT is the wire-to-plate spacing in units of inches. HDUCT is read with an F5.2 format in columns 11-15.

V-I curves and operating points for a six section ESP will be printed. If the ESP is not similar to a utility fly ash precipitator, a complete data set appropriate for an efficiency calculation with NVI set to 2 is required. If MODL = 3 on card 1, the calculation will terminate after the calculation and printing of the V-I curve data for the first electrical section.

SECTION 6

GUIDE TO THE USE OF OPTIONS

There are several options available in the operation of the ESP model. These options concern the type of data to be read into the program, the processes used to calculate the collection efficiency, which effects the calculation accuracy and the run time, and the amount of data which will be printed. The options are listed below with a discussion of the results of the different choices available. Table 5 summarizes these choices.

1. NEST determines the method by which the electric fields in the ESP are calculated. If NEST = 1, a rigorous calculation of the fields is performed by subroutines EFLD1 or EFLD2 (determined by NVI). If NEST = 2, the fields are estimated, resulting in a time reduction of about a factor of 15. However, the accuracy of the estimated fields varies with the application and in some cases, the estimated efficiencies may differ appreciably from the rigorously calculated values. If NEST = 2, the particle charges are calculated as if NCALC = 1. Table 6 shows some of the effects of changing this variable.

2. NVI determines whether the electric field calculation will be performed by subroutine EFLD1 or subroutine EFLD2. If the operating conditions are known, setting NVI = 1 will cause EFLD1 to calculate the fields. If the operating conditions are not known, setting NVI = 2 will cause EFLD2 to calculate a V-I curve to determine the operating conditions and then calculate the electric fields. This process takes much more computer time than the field calculation from known operating conditions.

3. NCALC determines the method of calculating the particle charge. If NCALC = 0, equation 12 (Volume 1) is integrated to give the charge. If NCALC = 1, the charge is found from equation 15 (Volume 1), which gives the sum of the charges from classical field and diffusion charging theories. In general, equation 15 gives fairly accurate results in much less time; however, for careful work, equation 12 should be used. Table 6 shows some of the effects of changing this variable.

4. NDIST determines the type of inlet particle size distribution data which must be read into the program. If NDIST = 1, the user must supply a measured particle size distribution. If

TABLE 5
SUMMARY OF PROGRAMMING OPTIONS

Variable	Value	Effected Process	Effect	Subroutines	Accuracy	Time	Comments
NEST	1	Calculation of electric fields	Rigorous calculation	EFLD1,EFLD2	High	High	
	2		Estimation	-	Variable	Low	Estimates particle charge
NVI	1	Calculation of electric fields	Input known operating conditions	EFLD1	Higher	Lower	
	2		Calculate operating conditions	EFLD2	Lower	Higher	Time is much higher
NCALC	0	Calculation of particle charge	Integrated charge (eq. 12)	CHARGN	High	High	
	1		Summed charge (eq. 15)	CHARGSUM	Variable	Low	
NDIST	1	Inlet particle size distribution	User supplied distribution	LNFIT	Higher	Same	Use NDIST=1 if possible as distribution may not be log-normal
	2		Calculated log-normal distribution	LNDIST	Lower	Same	
NRAP	0	Calculation of rapping reentrainment	Estimation	ADJUST	Good	Low	Average of 6 power plants
	1-3		Dynamic calculation	RAPPE	Variable	High	Must be tailored to each use. Very flexible. Use NEST=2 due length.
MODL	0	Type of input data	Same input data as Revision 1	-	-	-	-
	1		All metric input data	-	-	-	-
	2		Internal data set	INTERN	-	-	Requires resistivity and wire-to-plate spacing only
	3		Stops after V-I curve printed	EFLD2 or INTERN	-	-	-
NOPRNT	0	Amount of output data printed	All data printed	-	-	-	-
	1		Particle charging data and some opacity data not printed	-	-	-	-
	2		Also deletes printing of incremental data	-	-	-	-
NNPRINT	-	Data checking routine output	Allows data diagnostics to be separated from other output	CHEKIN	-	-	-

TABLE 6. EFFECTS OF VARYING NEST AND NCALC

	NEST	NCALC	TIME(SEC)	EFFICIENCY(%)
ESP #1	1	0	152	95.99
	1	1	89	96.69
	2	1	8	96.93
ESP #2*	1	0	2068	86.0
	1	1	775	83.2
ESP #3	1	0	1684	99.31**
	1	1	600	99.66
	2	1	97	99.71

*For NVI = 2, setting NEST = 2 has the same effect as setting NCALC = 1.

**Only the first of the 4 efficiencies calculated is shown.

NDIST = 2, the program calculates a log-normal distribution based on parameters provided by the user. Since some inlet size distributions differ significantly from a log-normal distribution, it is important to use measured data if it is available.

5. NRAP determines which type of rapping reentrainment calculation will be performed and how much data will be printed. If NRAP = 0, the collection efficiency will be adjusted by an empirical relationship based on a rapping reentrainment study in 6 coal-fired power plants. This adjustment takes very little time and yields good results for full-sized precipitators collecting fly ash. There is inadequate data to evaluate the suitability of this correction for precipitators collecting other materials. If NRAP = 1, 2, or 3, the rapping reentrainment calculation is performed by repeating the collection efficiency calculation with the reentrained dust being added to the dust already present in the gas flow at the point of reentrainment. The advantage of this process is that it is highly flexible and can be used to study changes in the rapping pattern. The disadvantages are that there is no standard data set available (instead the data must be tailored to each application) and that a large increase in computer time is required. The time increase is at least 2n where n is the number of raps in the rapping schedule. If only the rap of the last section is modeled, this is still a factor of 2. For this reason, the use of the estimation procedures (NEST = 2) is recommended when NRAP $\neq$ 0.

6. MODL determines the type of input data required by the program. If MODL = 0, the data set must be in the mixed metric-English units required by previous versions of the model. If MODL = 1, the data must be entirely in metric units. If MODL = 2, only resistivity and wire-to-plate spacing are read into the program. The remainder of the data is contained in subroutine INTERN. This option causes the model to generate efficiency data based on a study of utility fly ash precipitators for a wide range of SCA values. This is useful as a first step in establishing the ESP requirements for a particular application. However, it must be emphasized that this procedure can only provide a rough estimate of ESP needs for use as a starting point in a rigorous investigation. If MODL = 3, the program serves as a V-I curve generator.

7. NOPRNT determines the amount of charging and opacity data which is printed. If NOPRNT $\neq$ 0, the particle charge summary is not printed. The printing of differential opacity data is also deleted, leaving only the total opacity figures. The purpose of this option is to reduce the number of pages of printed output when the deleted data is not needed.

8. Subroutine CHEKIN checks the input data for errors or unusually large or small values of the ESP operating conditions. Warning messages generated in this subroutine are listed at the top of the printed output of the program. In some cases it may be desirable to print these messages to a different file or device than the remainder of the program output. This can be accomplished by changing one statement in subroutine CHECKIN. In the main routine, the variable NPRNT is used to define the distination device for the program output. In subroutine CHEKIN, the output distination is defined by the variable NNPRNT which is set equal to NPRNT. To change the distination of the warning messages, NNPRNT must be redefined. A comment statement identifies the proper statement in subroutine CHEKIN.

SECTION 7

DESCRIPTION OF OUTPUT DATA

GENERAL DESCRIPTION

The output data from the computer program are divided into several sections. The types of information contained in the different sections for the case where NRAP = 0 are listed in order below.

(1) Printout of all input data.
(2) Incremental analysis of precipitator performance.
(3) Charging rates for the different particle sizes.
(4) Charge accumulated on the different particle sizes.
(5) Particle size range statistics.
(6) Unadjusted migration velocities and collection efficiencies and discrete outlet mass loadings.
(7) Visible emission parameters.
(8) Summary table of precipitator operating parameters and performance.

For the case where NRAP $\neq$ 0, the following types of information are contained in the different sections:

(1) Printout of all input data.
(2) Incremental analysis of precipitator performance.
(3) Precipitator output statistics for each rapping puff including visible emission parameters if indicated.

In the following subsections, the information contained in the different sections listed above will be described in detail.

PRINTOUT OF INPUT DATA

The first section of printout which is generated in subroutine PRTINP contains a listing of all the input data. The first piece of information which is printed out in this section is a description of the organizations involved in the development of the model and the date of the latest revision. The second piece of information which is printed out is a statement identifying the data set number. Next, in sequence, each input data card number is printed out and is followed by a sequential list of the data entries on that particular card. The individual data entries are printed out in terms of the variable name, numerical value, and input units.

INCREMENTAL ANALYSIS OF PRECIPITATOR PERFORMANCE

This section of output data which is generated in subroutine PRTINC provides a printout of those parameters of importance which vary along the length of the precipitator. This includes data which change from one electrical section to the next and from one increment of length to the next.

The first piece of information which is printed out in this section is the inputted information that describes the particular calculation being performed. Second, the section number is printed.

Third, the names, values, and units of those parameters of importance which may be section-dependent are printed out in three columns. Most of this information is of interest in debugging the model and in looking for problems with the model. The first column contains the following variables in the designated order:

(1) section length in units of m;

(2) size of length increments to be taken in the given section in m;

(3) total collection plate area in a given section in units of m^2;

(4) wire-to-wire spacing in units of m;

(5) wire-to-plate spacing in units of m; and

(6) incoming dust loading in units of kg/m^3.

The second column contains the following variables in the designated order:

(1) gas temperature in units of °K;

(2) gas pressure in units of atm;

(3) gas viscosity in units of kg/(m-sec);

(4) gas volume flow rate in units of m^3/sec;

(5) gas linear flow velocity in units of m/sec; and

(6) actual gas ion mobility in units of $m^2/(V\text{-}sec)$.

The third column contains the following variables in the designated order:

(1) applied voltage in units of volts;

(2) total current in a given section in units of A;

(3) current density in units of A/m^2;

(4) current per meter of wire in units of A/m;

(5) average electric field in the deposited dust layer in units of V/m; and

(6) estimated mass penetration per increment in units of %.

Fourth, those parameters of importance which depend on a particular length increment are printed out in a table. The table contains 11 columns and a number of rows equal to the number of length increments in the given section. The following is a sequential list of the column headings, along with their descriptions.

(1)	INCREMENT NUMBER	is the increment number for which the calculations have been made.
(2)	ROVRI(RIOVR)	is the ratio of the total charge density to the ionic charge density and is dimensionless. ROVRI is printed out when NVI = 1. If NVI = 2, RIOVR is printed out. RIOVR is the ratio of the ionic charge density to the total charge density and is dimensionless.
(3)	E AVERAGE	is the average electric field in units of V/m. If NVI = 1, ERAVG is determined by dividing the applied voltage by the wire-to-plate spacing. If NVI = 2, ERAVG is determined by averaging the electric field over the 2NY-2 strips which are contained in a wire-to-wire spacing and are established by the grid use in the calculation of the electrical conditions.
(4)	E PLATE	is the average electric field at the plate in units of V/m.
(5)	REDUCED FID	is the average free ion density available for particle charging in units of $\#/m^3$.
(6)	J TOTAL	is the average current density at the plate in units of nA/cm^2.
(7)	DUST MMD REMOVED	is the mass median diameter of the collected material in units of m.
(8)	DUST KG/M3 REMOVED	is the amount of material collected in units of kg per m^3 of gas.
(9)	DUST LAYER	is the thickness of the collected particulate layer in units of mm/min.

(10) J DUST is the average current density at the plate due to particles in units of A/m^2.

(11) J IONS is the average current density at the plate due to ions in units of A/m^2.

The data output beginning with the section number and section length and ending at the present point is repeated for each section of the precipitator. After the data concerning the last section are printed out, the estimated or design efficiency and the uncorrected computed efficiency are printed out. If NVI = 1, the incremental analysis of precipitator performance along with its associated printout will be repeated until either the value of NITER is reached or the uncorrected computed efficiency is within 0.05% of the estimated efficiency.

If NVI = 2, the printout of output data discussed above will be altered somewhat in order to display data concerning the voltage-current calculations. If VISAME = 2 and VISKIP = 2, then, before the data concerning each section is printed out, the clean gas voltage-current density-field at the plate relationship will be printed out and will be preceded by a heading to that effect. The variables VW, ACDNTY, and AEPLT which are the applied voltage (V), average current density at the plate (A/m^2), and average electric field at the plate (V/m), respectively, will be printed out in columns. Also, before the data concerning each length increment is printed out, the dirty gas voltage-current density-field at the plate relationship will be printed out and will be preceded by a heading to that effect. The variables VW, ACDNTY, and AEPLT will be displayed as discussed above.

If VISAME = 1 and VISKIP = 2, the printout will be the same as for VISAME = 2 and VISKIP = 2 except that the clean gas voltage-current density-field at the plate relationship will be printed out only prior to the data concerning the first section. If VISAME = 2 with VISKIP = 1 or NEST = 2, the printout will be the same as for VISAME = 2 and VISKIP = 2 except that the dirty gas voltage-current density-field at the plate relationship will not be printed out prior to each incremental length. If VISAME = 1 with VISKIP = 1 or NEST = 2, the printout will be the same as for NVI = 1 except that the clean gas voltage-current density-field at the plate relationship will be printed out prior to the data concerning the first section.

CHARGING RATES FOR THE DIFFERENT PARTICLE SIZES

This section of output data which is generated in subroutine CHGSUM begins by stating the method by which particle charges were determined. Next, a table is printed out which contains, for each particle size, values of the ratio of the charge accumulated by a given particle size through a given increment of travel to the saturation charge in the last section. The number of columns in the table is determined by the number of particle size bands in the inlet particle size histogram and the number of rows is determined by the number of increments into which the precipitator has been divided. The column headings are the actual values of the midpoints of the size bands in units of μm and the row headings are the increment numbers. The entries in the table are designated by Q/QSATF.

CHARGE ACCUMULATED ON THE DIFFERENT PARTICLE SIZES

This section of output data which is generated in subroutine CHGSUM consists of a table which contains, for each particle size, the values of the charge in coulombs accumulated by a given particle size through a given increment of travel. The number of columns in the table is determined by the number of particle size bands in the inlet particle size histogram and the number of rows is determined by the number of increments into which the precipitator has been divided. The column headings are the actual values of the midpoints of the size bands in units of μm and the row headings are the increment numbers.

PARTICLE SIZE RANGE STATISTICS

This section of printout is generated in subroutine ADJUST. The data output in this section begins by stating which set of values of ASNUCK(I), AZIGGY(I), and ZNUMS(I) is under consideration. Next, a table is printed out which contains information of importance which is dependent on particle size. This table has 11 columns and the number of rows is determined by the number of particle size bands in the inlet particle size histogram. The column headings and their descriptions are given in order below.

(1) PARTICLE DIAMETER is the midpoint of a particle size band in units of μm.

(2) CCF is the Cunningham correction factor for a given particle size and is dimensionless.

(3) INLET % IN BAND is the percentage by mass of a given particle size band in the inlet particle size distribution in units of %.

(4) OUTLET % IN BAND is the percentage by mass of a given particle size band in the no-rap outlet emissions in units of %.

(5) CORRECTED OUTLET % is the percentage by mass of a given particle size band in the rap + no-rap outlet emissions in units of %.

(6) NO-RAP EFFICIENCY is the collection efficiency for a given particle size band under no-rap conditions in units of %.

(7) NO-RAP MIG. VEL. is the effective migration velocity for a given particle size band under no-rap conditions in units of cm/sec.

(8) NO-RAP PEN. is the penetration of a given particle size band under no-rap conditions in units of %.

(9) CORRECTED EFFICIENCY is the collection efficiency for a given particle size band under rap + no-rap conditions in units of %.

(10) CORRECTED MIG. VEL. is the effective migration velocity for a given particle size band under rap + no-rap conditions in units of cm/sec.

(11) CORRECTED PENETRATION is the penetration of a given particle size band under rap + no-rap conditions in units of %.

Next, 17 (or 18 of NDIST = 1) lines of data are printed out which contain information regarding overall mass efficiency, precipitation rate parameter, and particle size distribution under various conditions. In the following, a sequential listing of this information is presented and discussed.

- The stated and uncorrected computed efficiencies are printed on this line. If NVI = 1, the stated efficiency corresponds to the last estimated overall mass efficiency used in the calculations. If NVI = 2, the stated efficiency corresponds to the inputted design efficiency. The computed efficiency is the uncorrected ideal overall mass collection efficiency.

- The mass median diameter of the inlet particle size distribution in units of μm is printed out on this line.

- The geometric standard deviation of the inlet particle size distribution is printed out on this line.

- If NDIST = 1, the MMD and σ_p were obtained from a log-normal fit of the inlet particle size distribution and the quality of the fit (GFIT) is printed out on this line. A value of 1 indicates a perfect fit whereas values less than 1 indicate the extent to which the distribution deviates from a log-normal distribution. If the goodness of fit is much less than 1, the distribution deviates significantly from a log-normal distribution and the values for the MMD and σ_p obtained from the fitting procedure may not be meaningful with respect to the actual distribution. Thus, when the MMD and σ_p are of importance, the user must take care in examining the goodness of fit and comparing the fitted MMD and σ_p with the actual distribution. Values of $(GFIT)^2 > 0.985$ are sufficient to justify using a log-normal fit for many purposes. If NDIST = 1, a true log-normal distribution is used based on a MMD and σ_p which are inputted and this line of printout is omitted.

- The values of the chosen nonideal conditions of normalized standard deviation of the gas velocity distribution, fraction of gas bypassage and/or non-rapping particle reentrainment per stage, and the number of stages are printed out on the next 3 lines.

- The value of the indicator NTEMP is printed out on this line in order to indicate whether the rapping loss calculation is for a hot or cold side precipitator.

- The mass median diameter of the rapping puff size distribution (RMMD) in units of μm is printed out on this line.

- The geometric standard deviation of the rapping puff size distribution (RSIGMA) is printed out on this line.

- The overall adjusted no-rap efficiency in units of % is printed out on this line. This efficiency is obtained by correcting the uncorrected ideal migration velocities for gas sneakage and/or non-rapping particle reentrainment, gas velocity distribution, and empirical no-rap correction factors in order to determine adjusted no-rap migration velocities. Adjusted no-rap efficiencies are calculated from the corresponding migration velocities and these are used to determine the overall adjusted no-rap efficiency.

- The mass median diameter of the outlet particle size distribution under no-rap conditions in units of μm is printed out on this line.

- The geometric standard deviation of the outlet particle size distribution under no-rap conditions is printed out on this line.

- The log-normal quality of fit for the outlet particle size distribution under no-rap conditions is printed out on this line. As before, care must be taken in interpreting the MMD and σ_p and their meaningfulness must be judged in terms of the quality of fit and the actual size distribution.

- The precipitation rate parameter under no-rap conditions in units of cm/sec is printed out on this line. This quantity is determined by using the adjusted no-rap efficiency in the exponential-type equation relating efficiency and migration velocity and solving for the migration velocity.

• The final corrected overall mass collection efficiency in units of % which includes rapping losses is printed out on this line.

• The final corrected mass median diameter of the outlet particle size distribution under rap + no-rap conditions in units of μm is printed out on this line.

• The final corrected geometric standard deviation of the outlet particle size distribution under rap + no-rap conditions is printed out on this line.

• The log-normal quality of fit for the outlet particle size distribution under rap + no-rap conditions is printed out on this line. As before, care must be taken in interpreting the MMD and σ_p and their meaningfulness must be judged in terms of the quality of fit and the actual size distribution.

• The precipitation rate parameter under rap + no-rap conditions in units of cm/sec is printed out on this line. This quantity is determined by using the final corrected overall mass efficiency in the exponential-type equation relating efficiency and migration velocity and solving for the migration velocity.

UNADJUSTED MIGRATION VELOCITIES AND DISCRETE OUTLET MASS LOADINGS

This section of output data which is generated in subroutine ADJUST consists of a table which contains information for each particle size band concerning the unadjusted migration velocity and collection efficiency and the outlet mass loadings. The table has 7 columns and a number of rows which is equal to the number of particle size bands. The following is a sequential listing of the column headings which contains descriptions of the output variables.

(1) PARTICLE DIAM. (M) is a column containing the midpoint of each particle size band.

(2) IDEAL UNADJUSTED MIG. VEL. (CM/SEC) is a column containing the ideal uncorrected migration velocity for each particle size band. These values are obtained from the ideal calculation of particle collection efficiency and contain no empirical adjustments.

(3) IDEAL UNADJUSTED EFFICIENCY % is a column containing the ideal uncorrected collection efficiency for each particle size band.

(4) NO-RAP DM/DLOGD(MG/DSCM) is a column containing the discrete mass loading in each size band under no-rap

conditions. The discrete mass loading for a given particle size band is determined by calculating $\Delta M/\Delta \log_{10} D$, using the NO-RAP outlet particle size distribution and the total NO-RAP outlet mass loading where ΔM is the mass loading in the size band in units of mg/DSCM and $\Delta \log_{10} D$ is the difference of the $\log_{10}$ of the particle diameter in units of m at the upper endpoint of the size band and the lower endpoint.

(5) RAPPING PUFF DM/DLOGD/(MG/DSCM) is a column containing the discrete mass loading in each size band for the rapping puff (contribution due to rapping). The discrete madd loading for a given size band is determined as discussed above using the rapping puff particle size distribution and the mass loading for the rapping puff.

(6) NO-RAP+RAP PUFF DM/DLOGD(MG/DSCM) is a column containing the outlet discrete mass loading in each size band under no-rap + rap conditions. The discrete mass loading for a given size band is determined as discussed above using the no-rap + rap outlet particle size distribution and the total no-rap + rap outlet mass loading.

(7) RAPPING PUFF DISTRIBUTION (%) is a column containing the percentage by mass of each particle size band in the rapping puff. This distribution is log-normal and is constructed based on a specified MMD and σ_p.

VISIBLE EMISSION PARAMETERS

This section of the program output is generated in subroutine OPAC. The data gives the opacity of the effluent gas with and without rapping. Different amounts of data are printed depending on the value of the variable NOPRNT and NRAP. A description of the data printed in this section is given below.

(1) Light beam pathlength or stack diameter (m).
(2) Outlet particulate mass loading (g/m^3) for no-rap, rap, and combined effluents.
(3) Outlet particulate volume loading (cm^3/m^3) for no-rap, rap, and combined effluents.
(4) Particle density (g/cm^3).
(5) Differential extinction coefficient dE/dlogD (m^{-1}). If NOPRNT = 1, this data is not printed.
(6) Extinction coefficient E(m^{-1}). If NOPRNT = 1, this data is not printed.

(7) Specific mass extinction coefficient SPE (m^2/g). If NOPRNT - 1, this data is not printed.
(8) Specific particulate volume K (cm^3/m^2). If NOPRNT = 1, this data is not printed.
(9) Opacity (%). If NRAP = 3, this is the only opacity data printed.
(10) Refractive index used in each particle composition.
(11) Definitions of quantities. If NOPRNT = 1, this is not printed.

The differential extinction coefficients, total extinction coefficients, specific mass extinction coefficients, specific volumes, and opacity are given for the no-rap, rap, and combined no-rap + rap effluents for each of the compositions listed.

SUMMARY TABLE OF PRECIPITATOR OPERATING PARAMETERS AND PERFORMANCE

This section of output data which is generated in subroutine PRTSUM consists of a table which summarizes the results of the calculations and gives the values of the most important parameters. The table is divided into six types of information: (1) data set number, (2) ESP performance, (3) electrical conditions, (4) size distributions, (5) nonideal parameters, and (6) visible emissions.

The data set number is the number of the particular set of input data in a multiple data set which was used to generate this output. Following this is the number of the non-ideal condition set which is under consideration. Under ESP performance, the penetration corrected for rapping (%), the efficiency, and the specific collection area [$m^2/(m^3/sec)$ and $ft^2/1000$ ACFM] are printed. Under electrical conditions, the average applied voltage (V), average current density (nA/cm^2), and resistivity are printed out. Under size distributions, the MMD (μm) and σ_p for the inlet and outlet particle size distributions are printed out. The outlet MMD and σ_p are based on no-rap + rap conditions. Under nonideal parameters, the gas sneakage fraction per section, the normalized standard deviation of the gas velocity distribution and the MMD and σ_p of the rapping puff are printed out. Under visible emissions, the combined rap + no-rap opacity for particle composition #1, the stack diameter (m), and the total extinction coefficient (1/m) are printed.

PRECIPITATOR OUTPUT STATISTICS FOR EACH RAPPING PUFF

This section of output data is generated in subroutine RAPPE. The data describe the time dependent ESP effluent characteristic, growth of the dust layer, and plume opacity. The amount of data printed varies with the value of NRAP, with all of the information listed below being printed if NRAP = 1, less if NRAP = 2, and very little being printed if NRAP = 3. The numbers in brackets following each listed quantity indicate the values of NRAP for which the quantity is printed.

(1) Precipitator increments which are rapped at time t. [1,2,3].

(2) Description of the reentrained dust (if NDAT = 1 on preceding TIMRAP card). This is a listing of the rapping profile described in Section 4 of this volume. [1,2,3].

(3) Time. [1,2,3].

(4) Time interval since the last calculation of penetration. [1,2].

(5) Particle size band statistics at the ESP outlet. The following data are printed in tabular form: particle diameter, input percent-in-band, input dM/dlogD, output percent-in-band, output dM/dlogD, % efficiency, % penetration, penetration mass rate (kg/sec), penetration mass rate due to rapping (kg/sec). [1].

(6) Total instantaneous penetration mass rate (kg/sec) and rate due to rapping. [1,2].

(7) Instantaneous % penetration. [1,2,3].

(8) Cumulative penetration mass (kg). [1,2,3].

(9) Average total penetration mass rate (kg/sec). [1,2,3].

(10) Mass median diameter and geometric standard deviation of a log-normal particle size distribution fit to the ESP effluent. [1,2].

(11) Visible emission data printed with the variable NOPRNT = 1. [1,2,3].

(12) Dust layer thickness (mm) in each increment. [1,2].

(13) Percent penetration averaged over the period from time t = 0 through the end of each rapping puff. [1,2,3].

(14) Total penetration mass (kg) for each rapping puff. [1,2,3].

(15) Percent penetration in each size band averaged over the period from time t = 0 through the final rap. [1,2,3].

(16) Total penetration mass (kg) for the entire rapping scheme from time t = 0 through the final rap. [1,2,3].

SECTION 8

MACHINE-DEPENDENT FACTORS OF THE COMPUTER PROGRAM

Revision 3 of the ESP model is written in the FORTRAN IV language. Although this program was developed on a Digital Equipment Corporation DEC 2020 computer, it can be run on other computer systems with very few changes. For most computers, the first two executable statements in the program are the only changes required. The first of these defines the input (read) device unit number with the variable name NREAD. The second statement defines the output (write) device unit numbers with the variable name NPRNT. In order to run the program on a Control Data Corporation (CDC) computer system, it may also be necessary to change the single quotes found in many of the format statements to double quotes.

The FORTRAN code for the ESP model occupies 205,799 bytes of memory (7 bit) on the DEC System 20 computer. This is well within the memory limits of modern main-frame computers as well as many mini-computers. If the available computer does not have adequate memory, there are several ways in which the program size may be reduced. The first method is to eliminate those functions and options which will not be used. Several of the less essential functions have been identified and the fortran statements used only with those functions have been tagged in columns 72-80. These functions and their identifying tags are listed in Table 7. If the tag occurs on the first line of a subroutine, the entire subroutine is to be considered tagged. If all of the tagged statements and subroutines are removed from the program, the program length is reduced to 135,014 bytes. Two other methods of reducing the program length are by overlaying the program and by changing the sizes of the arrays within the program. Overlaying the program will allow all of the program functions to be retained but the computer will see only part of the program at any one time. The overlaying scheme must be custom designed for each application. The third size-reduction method, changing the sizes of the arrays, should only be considered in extreme cases as a very detailed study of the model is required to change the many interrelated variables involved.

A major factor in the use of a computer program of this size is the cost of operation. The greatest factor in the cost is usually the time the computer spends in performing the calculations

TABLE 7. FUNCTIONS TAGGED FOR EASY REMOVAL

Function	Tag
Dynamic rapping	RAP
Opacity calculation	OPAC
Internal data set	INT
Input data check	CHEK
Calculation of unknown electrical conditions	E2

(often referred to as central processing unit (CPU) time). Revision 3 of the model uses about one-tenth of the CPU time required by Revision 1 and should therefore be much less expensive to operate. In some cases, users are also charged according to the size of the program, although this practice is becoming much less common with large time-sharing machines. If such charges are imposed, the users should consider shortening the program as outlined in the previous paragraph. Frequent users of the model may reduce costs by using a compiled (i.e., machine language) version of the program rather than a FORTRAN version.

SECTION 9

EXAMPLE CASES AND COMPARISONS BETWEEN MODEL PREDICTIONS AND EXPERIMENTAL MEASUREMENTS

COMPARISONS OF MODEL PREDICTIONS WITH LABORATORY DATA

The examples shown in this report were run on a DEC 2020 computer. The same examples run on other computers may show very small differences in the calculated values due to the different number of significant figures supported by different computer systems. If the model is running properly, the differences will be insignificant.

[illegible] →

In order to have controlled experimental data with which to compare predictions of the mathematical model, a laboratory-scale precipitator has been constructed for the purpose of studying collection of fine particles under essentially idealized conditions. For the experiments which will be discussed here, the carrier gas was ambient air and the particulate source was an atomizer which produces an aerosol of dioctyl phthalate (DOP) containing many different particle sizes. A complete description of this precipitator and the experimental techniques used to make the measurements can be found elsewhere[6,7] and will not be given here.

~~6~~ 6, 7
[illegible] 4.5

In these experiments, the collected oil droplets drained from the collection electrode by gravity. Thus, particle reentrainment was not a factor. Gas bypassage of electrified regions was measured to be approximately 10% per baffled section for the four-section precipitator. The standard deviation of the velocity distribution at the inlet of the precipitator, expressed as a percentage of the average velocity, was measured to be approximately 10%. Since the particles were spherical, particle charging theories can be rigorously applied. The above considerations indicate that nonideal effects should be small. Thus, an ideal calculation of particle collection efficiencies should yield results which are only slightly higher than those determined experimentally.

Example 1

In this example, the predictions of the model are compared with measured fractional collection efficiencies and effective migration velocities for a plate-to-plate spacing of 25.4 cm, wire-to-wire spacing of 12.7 cm, wire radius of 0.1191 cm, gas velocity of 0.976 m/sec, and current density at the plate of 25.8 na/cm^2. These parameters are also characteristic of full-scale precipitators. The inlet mass loading and particle size distribution, operating voltages and currents, gas flow rate and velocity, and gas temperature and pressure were measured and are used as input data for the model. A reduced ionic effective mobility of 1.65 x 10^{-4} m^2/V-sec is used in the model since the use of this value results in good agreement between theoretical and experimental voltage-current characteristics for corona discharge in ambient air. Although the precipitator is divided into four baffled and independent electrical sections, the last two sections were connected together during the experiment and this is reflected in the input data to the model.

Figure 3 shows a comparison of the experimental fractional collection efficiencies and effective migration velocities with those predicted by the model. Table 8 gives the input data card set which was used to obtain the model predictions. The computation time required to run this example on the DEC 2020 computer was 112 seconds. The same data were run on an IBM 4341-2 computer in 19 seconds. The output data from the computer program are given in Appendix A.

In comparing the theoretical curves with the laboratory experimental data, certain considerations should be made. The adjusted, no-rap curves have built into them emprical correction factors which are a result of data acquired from full-scale precipitators. Since these correction factors most probably account for certain length-dependent mechanisms that are presently ignored in the model, it is doubtful that they would apply to the same degree in a much shorter laboratory precipitator. These mechanisms include particle charging near corona wires and particle concentration gradients. It might be expected that both of these mechanisms would enhance particle collection efficiencies and would be more effective the greater the length of the precipitator. Thus, the calculated adjusted, no-rap collection efficiencies should tend to be higher than those measured. Since the calculated ideal, unadjusted collection efficiencies are obtained without any consideration of the length-dependent mechanisms just mentioned, it might be expected that these values would be somewhat less than those measured.

Example 2

In this example, the predictions of the model are compared with measured fractional collection efficiencies and effective migration velocities obtained from experiments with the laboratory precipitator discussed in Example 1 when the gas velocity was 1.49 m/sec and the average current density at the plate was 10.8 nA/cm^2. All input quantities to the model were determined as previously discussed except the operating applied voltages and current densities. For this example, these quantities are

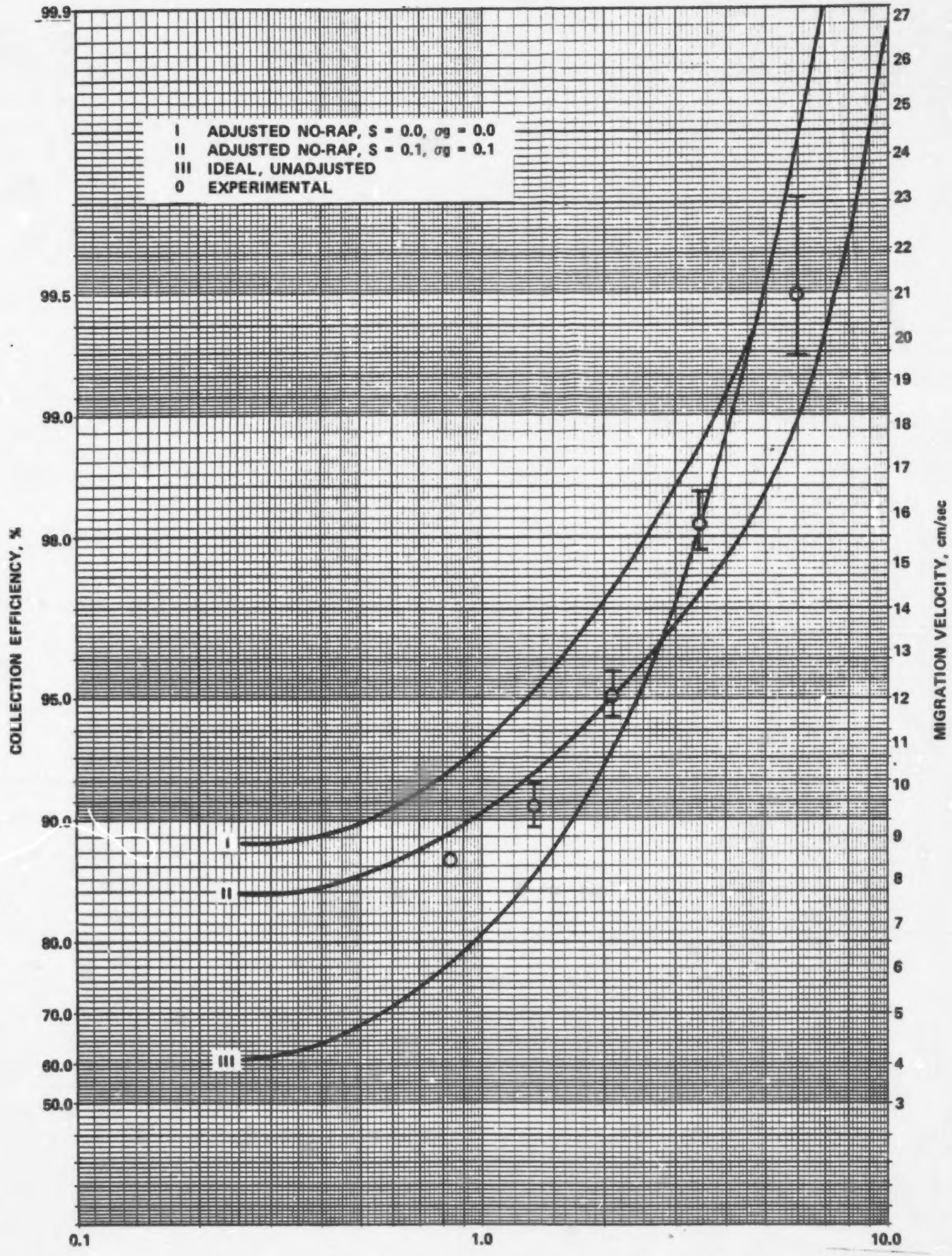

Figure 3. *Comparison of experimental fractional collection efficiencies and effective migration velocities obtained from a laboratory precipitator with those predicted by the model using the measured electrical conditions.*

Table 8. INPUT DATA FOR EXAMPLE 1

```
                                   COLUMN NUMBER
 CARD            1         2         3         4         5         6         7         8
NUMBER  12345678901234567890123456789012345678901234567890123456789012345678901234567890

   1    1601
   2    LAB ESP: SCA=125FT2/1000ACFM;J=24.0UA/FT2
   3    0101011010030001010102
   4    05
   5    0.015   10.0    99.0    1000.0  5.1     1.03    0.0001651.0     1500000.1.00E+09
   6    0.000.004.000.100.104.00
   7    0.20    0.30    0.40    0.50    0.60    0.80    1.00    1.20    1.40    1.80
   8    2.20    3.00    4.00    6.00    10.0    20.0
   9    0.0     0.0002  0.4002  1.0002  2.6672  7.6672  12.6002 17.6002 21.3332 29.3332
  10    36.0002 46.6672 57.3342 68.6672 80.6672 100.0
  11    03030306
  12     6.2500E+00 4.6000E+04 1.5000E-04 6.2500E+00 4.6875E-02 5.0000E+00 5.0000E+00
  13     2.5000E+00 2.0000E+02 3.2000E+00 7.6800E+01 1.0000E+00 1.8000E-05 8.3333E-01
  14     6.2500E+00 4.5800E+04 1.5000E-04 6.2500E+00 4.6875E-02 5.0000E+00 5.0000E+00
  15     2.5000E+00 2.0000E+02 3.2000E+00 7.6800E+01 1.0000E+00 1.8000E-05 8.3333E-01
  16     1.2500E+01 4.4400E+04 3.0000E-04 1.2500E+01 4.6875E-02 5.0000E+00 1.0000E+01
  17     2.5000E+00 2.0000E+02 3.2000E+00 7.6800E+01 1.0000E+00 1.8000E-05 8.3333E-01
  18    99
```

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predicted by the model by calculating clean-gas, voltage-current curves for each electrical section and estimating the reduction in current in each increment of length due to particles.

4 Figure 4 shows the measured voltage-current characteristics for the three electrical sections without and with particles. Also shown is the theoretical clean-air, voltage-current curve which was used in the calculations for each of the electrical sections. The theoretical curve was generated using a reduced effective ion mobility of 1.65 x 10^{-4} m^2/V-sec and a roughness factor of 0.90. Better fits to the clean-air curves could have been obtained by adjusting the reduced effective ion mobility and roughness factor and using slightly different values of these parameters in the different electrical sections. However, for purposes of illustrating the use of the theoretical voltage-current calculations, the agreement between the experimental curves and the theoretical curve is sufficient. At 10.8 nA/cm^2, the theoretical curve is slightly above the clean-air curves for sections 1 and 2 and is slightly below the clean-air curve for the last section.

5 Figure 5 shows a comparison of the experimental fractional collection efficiencies and effective migration velocities with those predicted by the model. Table 9 gives the input data card
9 set which was used to obtain the model predictions. The computation time required to run this example on the DEC 2020 computer was approximately 1,750 seconds. The output data from the computer program are given in Appendix B.

For sections 1, 2, and 3 and measured operating applied voltages of 40.8, 40.8, and 39.6 kV, respectively, the computer model utilizes operating applied voltages of 40.7, 40.7, and 39.5 kV, respectively, and predicts average current densities at the plate of 11.9, 11.8, and 8.9 nA/cm^2, respectively. The average value of the predicted current density over the length of the precipitator is 10.4 nA/cm^2 which compares favorably with the value of 10.8 nA/cm^2 which was maintained in each electrical section during the experiments. In this example, the reason why all the theoretical curves lie below the experimental data can be attributed to the procedure used in the calculations. When the voltage-current calculations are employed, the model takes into account the nonuniformity of the electric field and current density distributions instead of using average values for an entire electrical section based only on the applied voltage and the wire-to-plate spacing. On the average, this results in significantly lower current densities and electric fields for use in particle charging and particle collection than are used in the model when the operating voltage and currents are known. The effects of using this procedure are especially pronounced for lower current densities where the particle charging rates are low and longer residence times are required for particles to attain a limiting value of charge. Also, since the correction factors for the no-rap

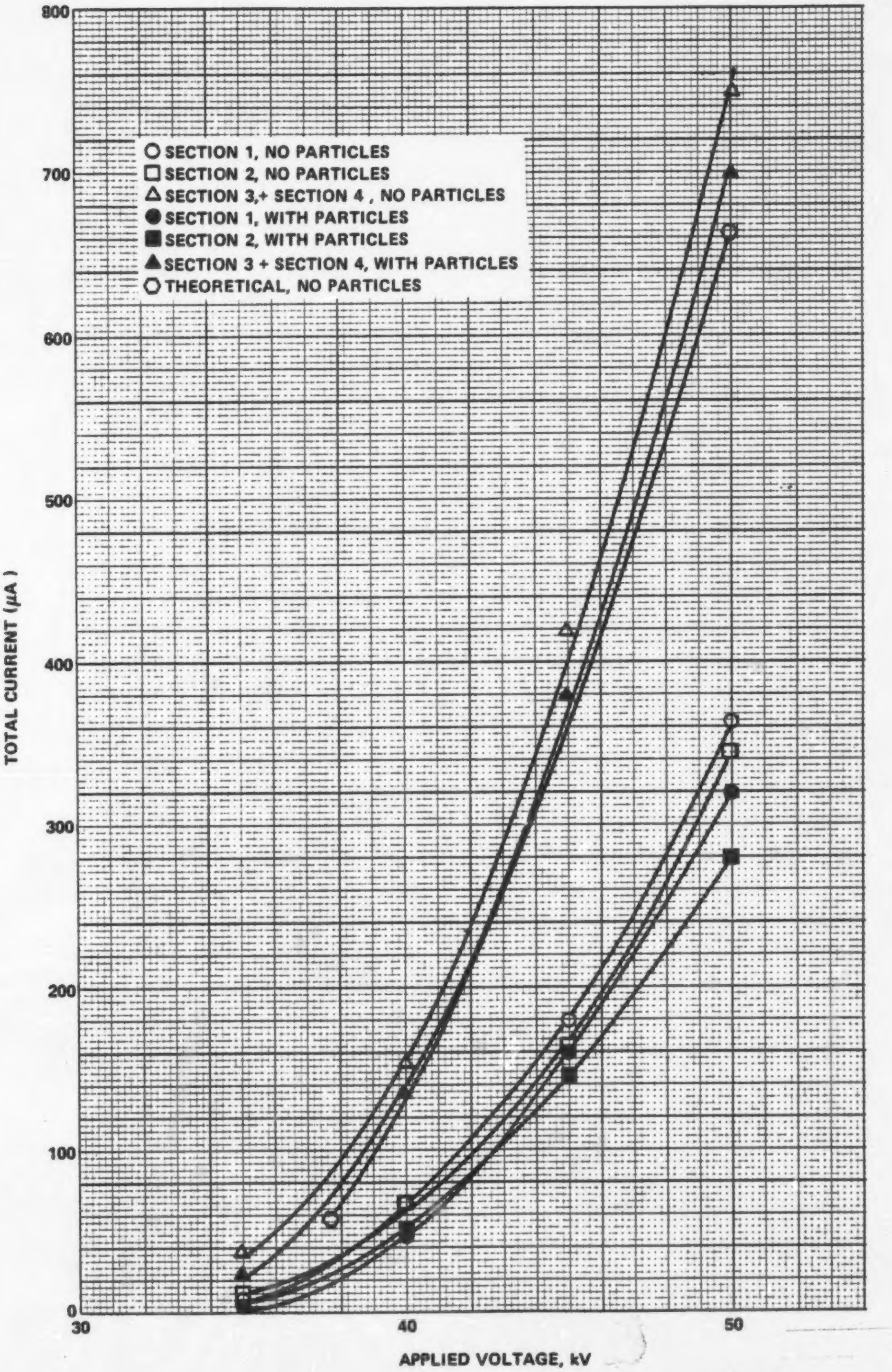

Figure 4. *Experimental and theoretical voltage-current curves for the laboratory precipitator.*

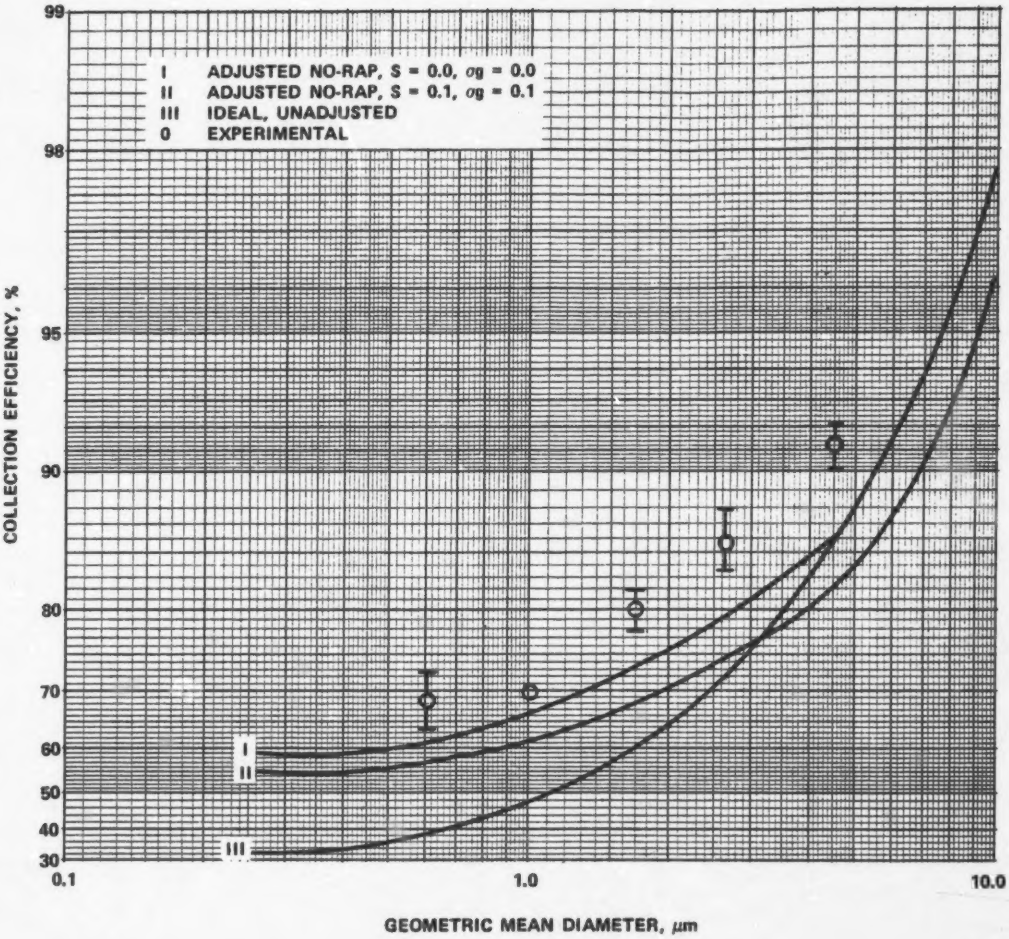

Figure 5. *Comparison of experimental fractional collection efficiencies obtained from a laboratory precipitator with those predicted by the model using theoretical voltage-current calculations.*

Table 9. INPUT DATA FOR EXAMPLE 2

```
                                             COLUMN NUMBER
 CARD               1         2         3         4         5         6         7         8
NUMBER     123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890

   1       1601
   2       LAB ESP: SCA=82FT2/1000ACFM;CALCULATED V-I FOR EACH ELECTRICAL SECTION
   3       0101021515010001010102
   4       05
   5       2002210102
   6       0.065    10.0     99.0     1000.0   5.1      1.03     0.0001651.0       1500000.1.00E+09
   7       0.0 0.0 4.0 0.1 0.1 4.0
   8       0.20     0.30     0.40     0.50     0.60     0.80     1.00     1.20     1.40     1.80
   9       2.20     3.0      4.0      6.0      10.0     20.0
  10       0.0      0.0076   0.0563   0.2682   0.8652   2.9845   5.9695   9.5515   12.835   19.7004
  11       26.8643  38.8042  49.2516  64.1765  79.1014  100.0
  12       03060612
  13       +6.2500E+00+4.0800E+04+6.2500E-05+6.2500E+00+4.6875E-02+5.0000E+00+5.0000E+00
  14       +2.5000E+00+3.0533E+02+4.8853E+00+7.6000E+01+1.0000E+00+1.8000E-05+4.1667E-01
  15       +9.0000E-01+6.0000E-05+2.0000E-05+2.0000E-05+3.8000E+04
  16       +6.2500E+00+4.0800E+04+6.2500E-05+6.2500E+00+4.6875E-02+5.0000E+00+5.0000E+00
  17       +2.5000E+00+3.0533E+02+4.8853E+00+7.6000E+01+1.0000E+00+1.8000E-05+4.1667E-01
  18       +9.0000E-01+6.0000E-05+2.0000E-05+2.0000E-05+3.8000E+04
  19       +1.2500E+01+3.9600E+04+1.2500E-04+1.2500E+01+4.6875E-02+5.0000E+00+1.0000E+01
  20       +2.5000E+00+3.0533E+02+4.8853E+00+7.6000E+01+1.0000E+00+1.8000E-05+4.1667E-01
  21       +9.0000E-01+6.0000E-05+2.0000E-05+2.0000E-05+3.8000E+04
  22       99
```

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migration velocities are based on comparisons of experimental data with results obtained from the model using known operating voltages and currents, these correction factors do not compensate enough for underprediction in this case.

COMPARISONS OF MODEL PREDICTIONS WITH FIELD DATA

Recent studies[5,8] have provided sufficient experimental data characteristic of full-scale, industrial precipitators with which to compare the predictions of the mathematical model. In these studies, the physical quantities which must be known in order to adequately apply the model have been measured. These quantities include the precipitator geometry, inlet mass loading and particle size distribution, voltage-current characteristics, average flow rate, velocity, temperature, and pressure of the gas stream, gas composition, and bulk particulate resistivity. The techniques for measuring these quantities are described elsewhere[9] in the literature and will not be discussed here. In the following two examples, the model is used to simulate the operation of two full-scale precipitators collecting fly ash and the predictions of the model are compared with the measured data.

Example 3

In this example, the predictions of the model are compared with measured fractional collection efficiencies, fractional effective migration velocities, and discrete outlet mass loadings for a cold-side precipitator. Table 10 gives the input data card set which was used in the model to simulate the operation of the precipitator. All fundamental input parameters having a significant effect on precipitator performance were measured or known except the reduced effective ion mobility and gas viscosity. The value of reduced effective ion mobility was assumed to be 2.2 x 10^{-4} m^2/V-sec which according to Table 1 may be somewhat low. The value of gas viscosity was obtained from Table 2 and it was assumed that air and the flue gas would have approximately the same viscosity at the same temperature and moisture content. The computation time required to run this example on the DEC 2020 computer was approximately 294 seconds.

Figure 6 shows a comparison of the experimental fractional collection efficiencies and effective migration velocities with those predicted by the model. Figure 7 shows a comparison of the experimental discrete outlet mass loadings with those predicted by the model. The output data from the computer program are given in Appendix C. In Figure 6, theoretical points are shown for pairs (σ_g, S) of σ_g and S with values of (0.0, 0.0) and (0.25,0.1). From experience with modeling full-scale precipitators, these values of the normalized standard deviation of the gas velocity distribution (σ_g) and the fraction per baffled section of gas sneakage and/or particle reentrainment without rapping (S) encompass the range of values which are typical of precipitators that are in good working condition. The particle size distribution of the "rapping puff" was determined by the experimental

Table 10. INPUT DATA FOR EXAMPLE 3

```
                                          COLUMN NUMBER
CARD             1         2         3         4         5         6         7         8
NUMBER  12345678901234567890123456789012345678901234567890123456789012345678901234567890

   1    1401       17.4
   2    FULL-SCALE,COLD-SIDE ESP:  PLANT A;  SCA=243FT2/1000ACFM; J=15.9UA/FT2
   3    0101011010030001010102
   4    05
   5    1.966   27.0    99.6    2270.0  100.0   1.2     0.00022 1.0     1500000.5.00E+10
   6    0.000.003.000.100.253.00
   7    0.10    0.30    0.50    0.90    1.30    1.90    3.10    3.90    5.10    6.90
   8    10.1    14.9    25.1    29.9
   9    0.0     0.033   0.286   1.189   2.004   3.524   7.048   8.70    10.352  12.334
  10    15.638  20.484  32.599  100.0
  11    03101010
  12    +2.6460E+04+4.0600E+04+2.7300E-01+1.5720E+04+8.2500E-02+5.5000E+00+1.2000E+01
  13    +3.6250E+00+3.2724E+05+4.1000E+00+3.1500E+02+1.0000E+00+2.2900E-05+9.0000E-01
  14    +2.6460E+04+4.2100E+04+4.3300E-01+1.5720E+04+8.2500E-02+5.5000E+00+1.2000E+01
  15    +3.6250E+00+3.2724E+05+4.1000E+00+3.1500E+02+1.0000E+00+2.2900E-05+9.0000E-01
  16    +2.6460E+04+4.2450E+04+5.5800E-01+1.5720E+04+8.2500E-02+5.5000E+00+1.2000E+01
  17    +3.6250E+00+3.2724E+05+4.1000E+00+3.1500E+02+1.0000E+00+2.2900E-05+9.0000E-01
  18    99
```

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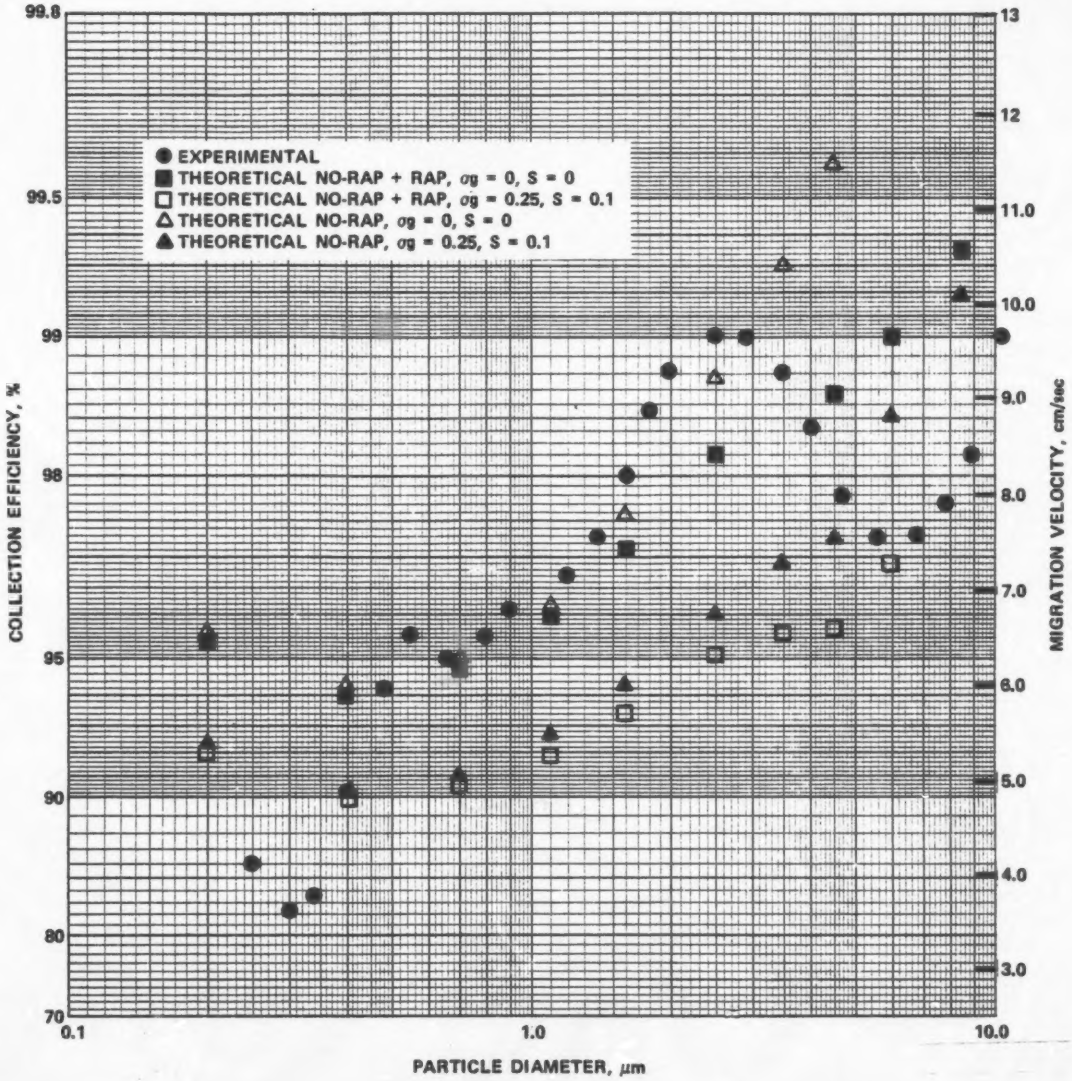

Figure 6. *Comparison of experimental fractional collection efficiencies and effective migration velocities obtained from a full-scale, cold-side precipitator with those predicted by the model.*

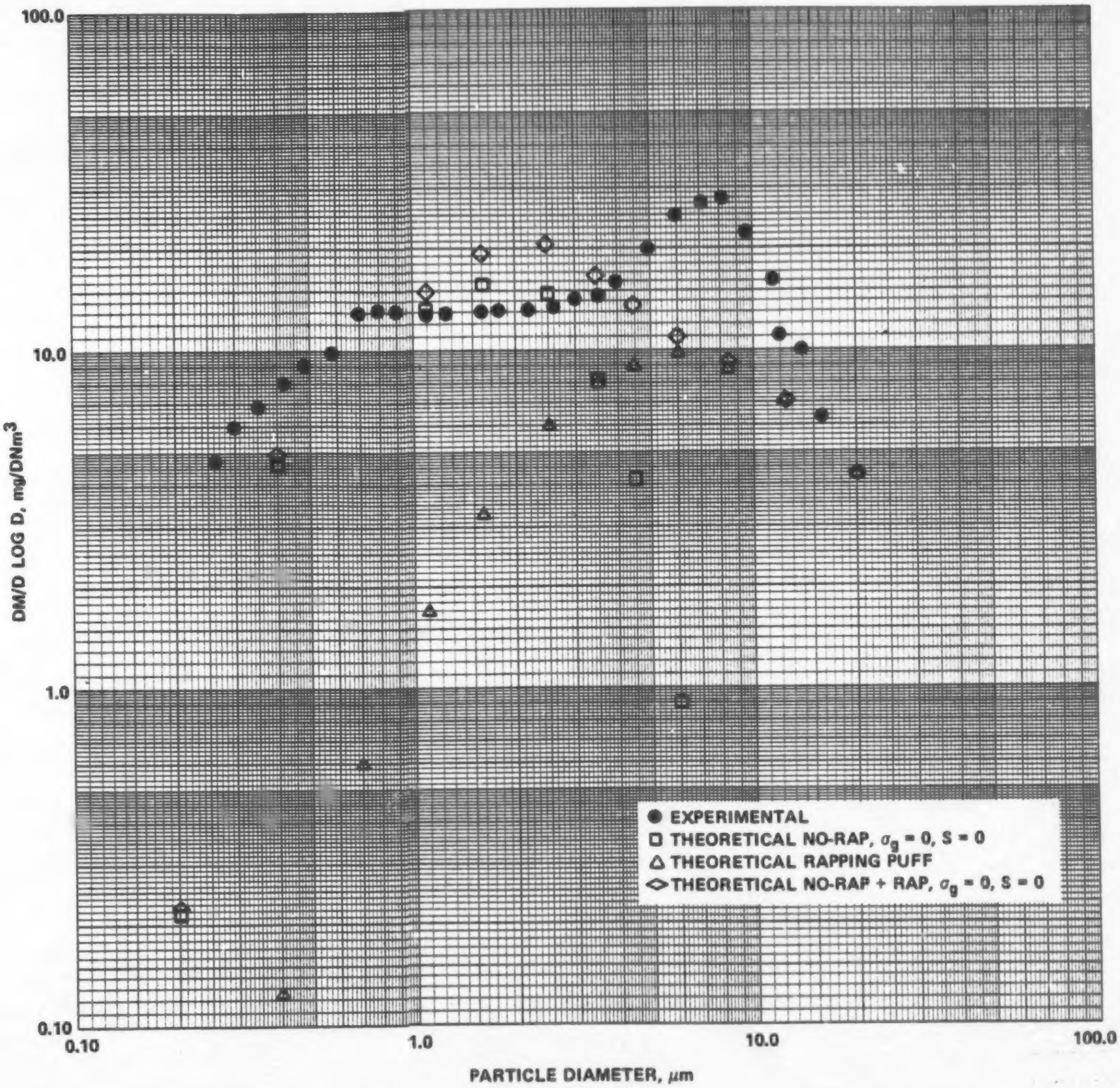

Figure 7. *Comparison of experimental discrete outlet mass loadings obtained from a full-scale, cold-side precipitator with those prediced by the model.*

log-normal distribution (MMD = 6.0 μm, σ_p = 2.5) which is built into the program. Since the theoretical NO-RAP points for σ_g = 0 and S = 0 agree well with the measured data up to approximately 3.0 μm and the theoretical NO-RAP+RAP points show less agreement with the measured data from 3.0 μm to 10.0 μm, the poorer agreement from 3.0 μm to 4.0 μm can be attributed to the "rapping puff" which was used. Better agreement would be obtained with a "rapping puff" which has a larger mass loading and a particle size distribution with a larger MMD. This is readily seen by examining Figure 7.

Example 4

In this example, the predictions of the model are compared with measured fractional collection efficiencies and migration velocities for a hot-side precipitator. Table 11 gives the input data card set which was used to simulate the operation of the precipitator. All fundamental input parameters were determined in the same manner as discussed in Example 3. The computation time required to run this example on the DEC 2020 computer was approximately 221 seconds.

Figure 8 shows a comparison of the experimental fractional collection efficiencies and effective migration velocities with those predicted by the model. The output data from the computer program are given in Appendix D.

EXAMPLE OF MODEL PREDICTIONS USING DYNAMIC RAPPING

Example 5

This example demonstrates the use of the dynamic rapping reentrainment calculation. The example uses the same precipitator and operating conditions as Example 3. In this ESP, there are 3 electrical sections with 42 lanes of gas flow. The first section is rapped 10 times/hour, the second is rapped 6 times/hour and the third is rapped once/hour. The 42 lanes are rapped two at a time giving in effect 21 lanes on a staggered schedule so that no two are rapped at the same time.

The input data for this example are shown in Table 12. When using dynamic rapping reentrainment, it is important to allow a complete rapping cycle to take place so that the least rapped section (usually the last) can accumulate a full load of collected dust before rapping. In this example, an estimated 25% of the collected dust is reentrained. The time required for the gas to flow past one incremental length is 0.22 sec and each rapping puff lasts 15 sec. Using the procedures listed in Section 5, these quantities yield a value of 0.000175 for REPCT and 315 sec for the total rapping puff duration. Since the shape of the rapping dust cloud is unknown, a square cloud of amplitude 1.0 and a duration of 315 sec was used in the rapping profile. The rapping schedule for ESP section 2 was rearranged slightly

Table 11. INPUT DATA FOR EXAMPLE 4

```
                                         COLUMN NUMBER
                1         2         3         4         5         6         7         8
CARD
NUMBER   12345678901234567890123456789012345678901234567890123456789012345678901234567890

  1      1501
  2      FULL-SCALE,HOT-SIDE ESP: PLANT B;SCA=390FT2/1000ACFM;J=34.3UA/FT2
  3      0101011010030001010202
  4      05
  5      2.51    36.0    99.6    2270.0  100.0    1.2     0.00022 1.0     1500000.1.90E+10
  6      0.000.004.000.100.254.00
  7      0.20    0.40    0.70    1.00    1.50    2.00    3.00    4.00    5.00    7.00
  8      10.00   15.00   25.00   30.0    100.0
  9      0.0     0.1479  0.57421 1.00922 1.72264 2.74926 6.52514 9.48321 11.1362513.05029
 10      15.6255520.1844530.9726935.49679100.0
 11      0409090909
 12      +4.2120E+04+3.5880E+04+1.2200E+00+5.6160E+04+5.4500E-02+4.5000E+00+1.2000E+01
 13      +4.5000E+00+4.3207E+05+3.7958E+00+6.2400E+02+1.0000E+00+2.8000E-05+1.0000E+00
 14      +4.2120E+04+3.3950E+04+1.6720E+00+5.6160E+04+5.4500E-02+4.5000E+00+1.2000E+01
 15      +4.5000E+00+4.3207E+05+3.7958E+00+6.2400E+02+1.0000E+00+2.8000E-05+1.0000E+00
 16      +4.2120E+04+2.9130E+04+1.4200E+00+5.6160E+04+5.4500E-02+4.5000E+00+1.2000E+01
 17      +4.5000E+00+4.3207E+05+3.7958E+00+6.2400E+02+1.0000E+00+2.8000E-05+1.0000E+00
 18      +4.2120E+04+2.7500E+04+1.4600E+00+5.6160E+04+5.4500E-02+4.5000E+00+1.2000E+01
 19      +4.5000E+00+4.3207E+05+3.7958E+00+6.2400E+02+1.0000E+00+2.8000E-05+1.0000E+00
 20      99
```

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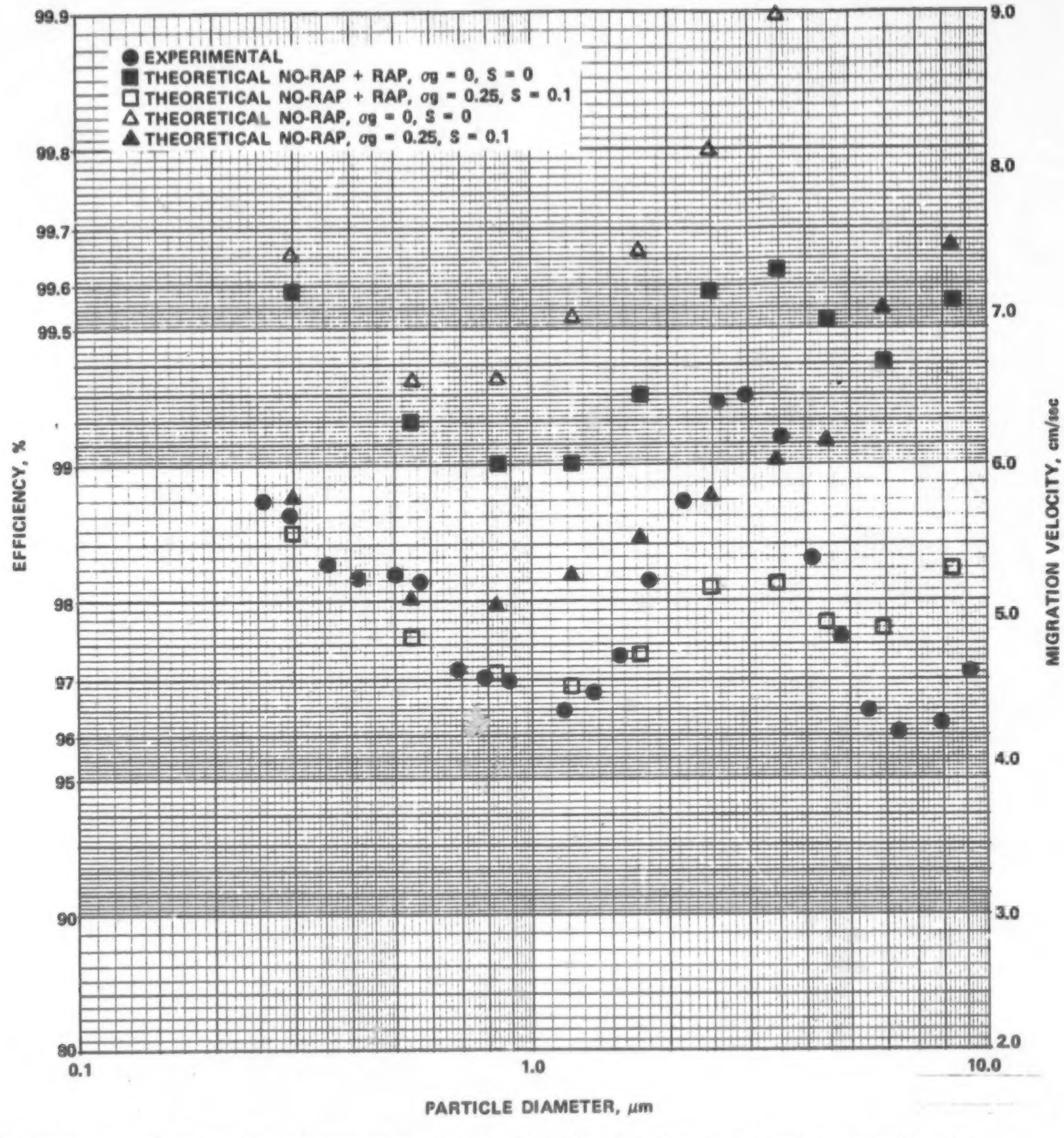

Figure 8. *Comparison of experimental fractional collection efficiencies and effective migration velocities obtained from a full-scale, hot-side precipitator with those predicted by the model.*

TABLE 12. INPUT DATA FOR EXAMPLE 5

```
                                             COLUMN NUMBER
 CARD            1         2         3         4         5         6         7         8
NUMBER  12345678901234567890123456789012345678901234567890123456789012345678901234567890

   1    1401030001 17.5
   2    FULL-SCALE,COLD-SIDE ESP:  PLANT A;  SCA=243FT2/1000ACFM; J=15.9UA/FT2
   3    0201011010010101010101
   4    1.966   27.0    99.6    2270.0  100.0   1.2     0.00022 1.0     1500000.5.00E+10
   5    0.000.003.00
   6    0.10    0.30    0.50    0.90    1.30    1.90    3.10    3.90    5.10    6.90
   7    10.1    14.9    25.1    29.9
   8    0.0     0.033   0.286   1.189   2.004   3.524   7.048   8.70    10.352  12.334
   9    15.638  20.484  32.599  100.0
  10    03101010
  11    +2.6460E+04+4.0600E+04+2.7300E-01+1.5720E+04+8.2500E-02+5.5000E+00+1.2000E+01
  12    +3.6250E+00+3.2724E+05+4.1000E+00+3.1500E+02+1.0000E+00+2.2900E-05+9.0000E-01
  13    +2.6460E+04+4.2100E+04+4.3300E-01+1.5720E+04+8.2500E-02+5.5000E+00+1.2000E+01
  14    +3.6250E+00+3.2724E+05+4.1000E+00+3.1500E+02+1.0000E+00+2.2900E-05+9.0000E-01
  15    +2.6460E+04+4.2450E+04+5.5800E-01+1.5720E+04+8.2500E-02+5.5000E+00+1.2000E+01
  16    +3.6250E+00+3.2724E+05+4.1000E+00+3.1500E+02+1.0000E+00+2.2900E-05+9.0000E-01
  17      6.      1111111111                                   .000175  1    1
  18       1.0
  19       1.0
  20       1.0
  21       10.   1.5
  22       10.   1.5
  23       10.   1.5
  24      315. 2000.
```

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TABLE 12. INPUT DATA FOR EXAMPLE 5, CONTINUED

```
                                         COLUMN NUMBER
  CARD           1         2         3         4         5         6         7         8
NUMBER  12345678901234567890123456789012345678901234567890123456789012345678901234567890
  25     12.      11111111112222222222                         .000175  1
  26     18.      1111111111                                   .000175  1
  27     24.      11111111112222222222                         .000175  1
  28     30.      11111111112222222222                         .000175  1
  29     36.      1111111111                                   .000175  1
  30     42.      11111111112222222222                         .000175  1
  31     48.      11111111112222222222                         .000175  1
  32     54.      1111111111                                   .000175  1
  33     60.      11111111112222222222                         .000175  1
  34     66.                          3333333333               .000175  1
  35
  36     99
```

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so that enough time is allowed between raps for a 315 second dust cloud. This resulted in the section 2 raps being unevenly spaced. The final section is rapped by itself as this section is the most critical in terms of rapping emissions.

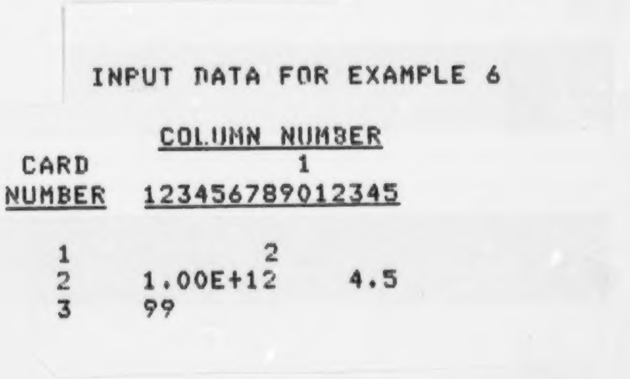
The overall particle collection efficiency measured at the power plant was 99.55%. The efficiency calculated by the dynamic rapping procedure was 99.66%. The efficiency calculated in Example 3 was 99.67% for the case with no non-ideal corrections ($S=0$ and $\sigma_g=0$). A comparison of the size dependent penetrations is shown in Figure 8, where the close fit of the dynamic rapping calculation to the 6 μm peak was obtained by reentraining a dust with a 10 μm mmd. No measured opacity data is available from this plant. However, the opacity was estimated to be in the 10-15% range. Dynamic rapping calculated 8.6% opacity without rapping, with 8.9% due to the section 1 raps, 9.3% due to the section 2 raps, and 14% due to the section 3 raps. Since a section 1 rap occurs every 17 seconds, the base line should be considered 9% with peaks to 14% when section 3 is rapped (every 2.8 minutes). Example 3 gives the opacity as 8.0% without rapping and 9.2% with rapping. The program output is reproduced in Appendix E. The time required to run this example on the DEC 2020 computer was approximately 120 seconds.

EXAMPLE OF MODEL PREDICTIONS USING THE INTERNAL DATA SET

Example 6

This example demonstrates the use of the internal data set. The input data required for this example is shown in Table 13. The program output is shown in abbreviated form in Appendix F. The time required to run this example on the DEC 2020 computer was approximately 47 seconds. Figure 10 shows predicted collection efficiencies as a function of resistivity and SCA for a plate separation of 11.4 cm (9 in.).

Table 13



```
    INPUT DATA FOR EXAMPLE 6

         COLUMN NUMBER
  CARD            1
 NUMBER  123456789012345

   1            2
   2     1.00E+12    4.5
   3     99
```

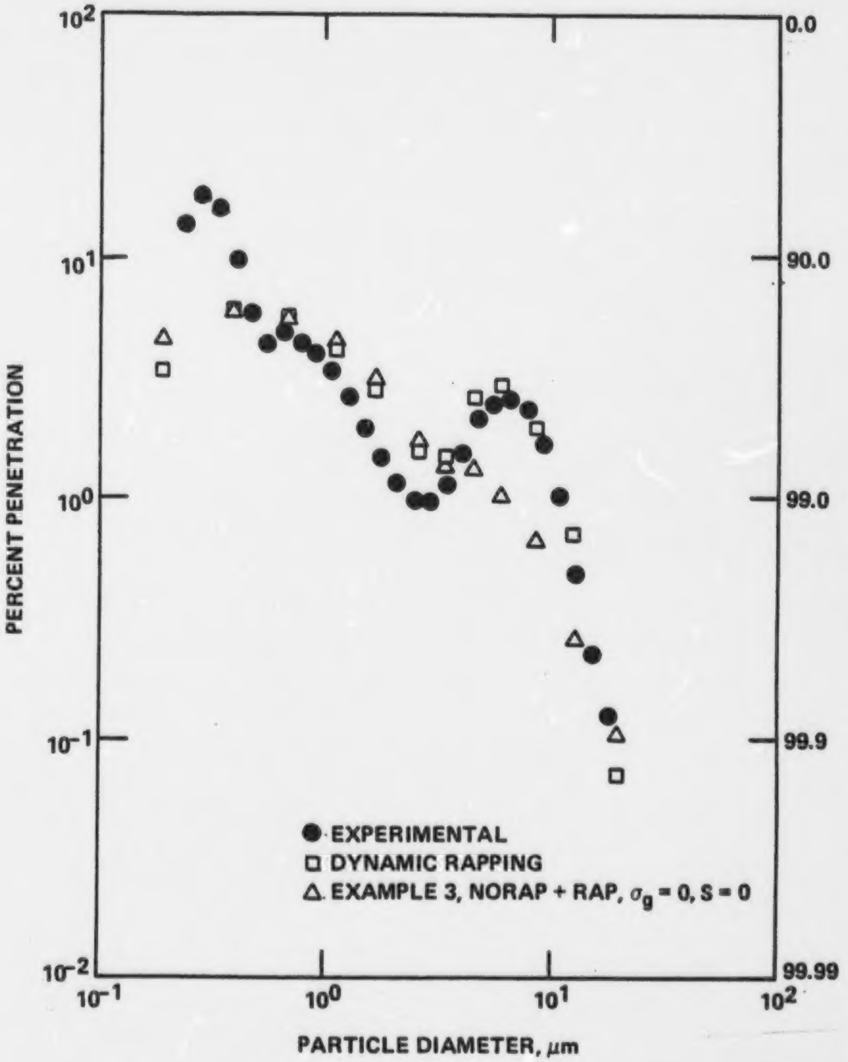


Figure 9. Comparison of standard and dynamic rapping reentrainment calculations.

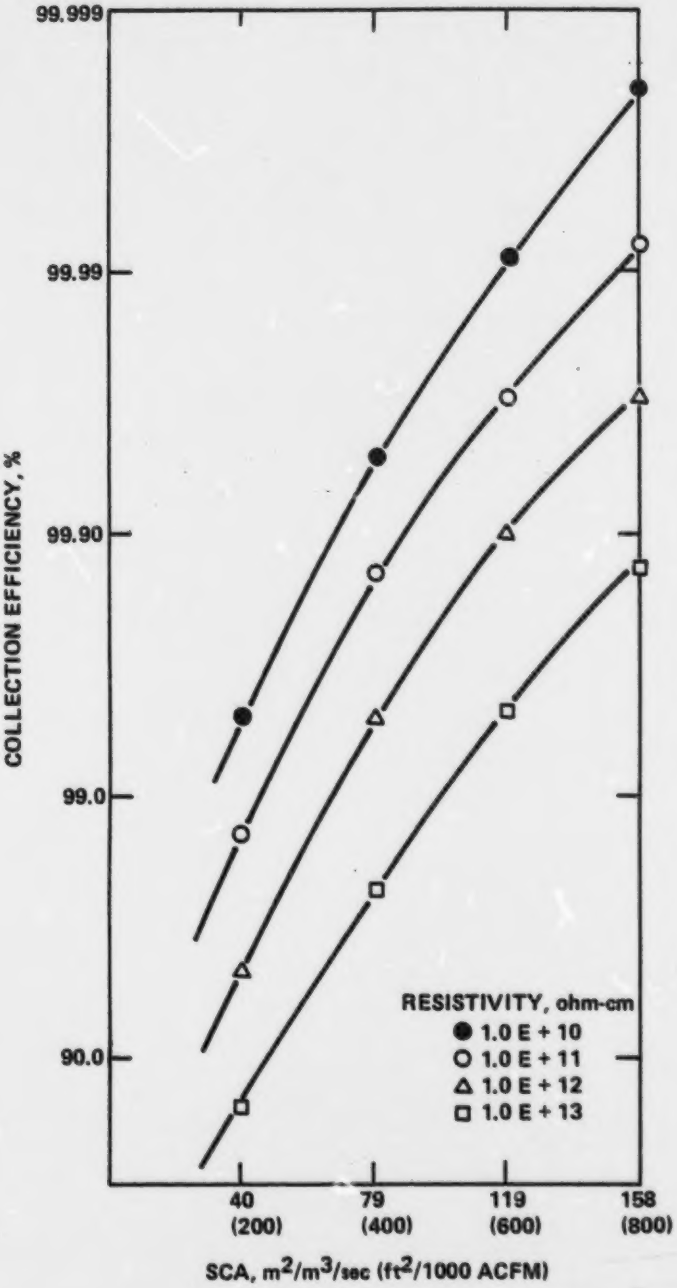


Figure 10. *Collection efficiency calculated by the internal data set as a function of resistivity and specific collection area (SCA).*

10

SECTION 10

APPLICATIONS OF THE MODEL

EFFECT OF PARTICLE SIZE DISTRIBUTION

The distribution of the various particle sizes entering a precipitator influences the electrical operating conditions and the overall mass collection efficiency. Normally, the distribution of particulate emissions from industrial sources can be approximated by a log-normal distribution. This type of distribution can be completely characterized by the mass median diameter (MMD) and the geometric standard deviation (σ_p), and the effect of both parameters on precipitator performance must be considered. The MMD provides a representative size for the distribution and σ_p provides a measure of the dispersion of the distribution.

The computer program for the model allows the user to specify the MMD and σ_p for a log-normal distribution, along with the desired particle size bands, and will then construct an inlet particle size distribution histogram for use in the model. By using a basic data set and shortened data sets, the effect of particle size distribution on precipitator performance can be easily obtained.

Example 7

In this example, the effects that certain particle size distributions can have on precipitator performance are estimated for the laboratory precipitator and conditions used in Example 1. Although the particle size distribution will influence the voltage-current characteristics and, depending on the mass loading, can sometimes have a considerable effect, it is assumed that the voltage-current characteristics remain constant in order to obtain trends. If a more representative calculation is necessary, this can be provided by using the option which calculates voltage-current characteristics but this requires considerably more computer time.

For this example, the effect of MMD on overall mass collection efficiency was estimated by holding σ_p fixed at a value of 2.5 and using values of 2.0, 5.0, 10.0, 15.0, and 25.0 μm for the MMD. The effect of σ_p on overall mass collection efficiency was estimated by holding the MMD fixed at 10 μm and using values of 1.5, 5.0, 10.0, and 15.0 for σ_p. The results obtained for $\sigma_p = 2.5$

and MMD = 10.0 μm when holding σ_p constant can also be used in analyzing the effect of σ_p on overall mass collection efficiency. Table 14 gives the input data card set which was used to perform the calculations. The computation time required to run this example on the DEC 2020 computer was approximately 1,180 seconds.

Figure 11 shows curves obtained from the calculations. Nonideal effects have been ignored in obtaining the curves which are shown. Excerpts from the output data from the computer program are given in Appendix G. The results of these calculations point out the importance of considering the effect of variations in particle size distribution on overall mass collection efficiency for a given specific collection area and set of electrical operating conditions. A precipitator should be designed with the capability of meeting emissions standards with a somewhat less favorable particle size distribution than that currently existing or that anticipated in order to provide a margin of safety. This is necessary because any changes in the process which produces the emissions may result in a less favorable particle size distribution.

EFFECT OF SPECIFIC COLLECTION AREA

An important parameter which influences the performance of a precipitator is called the specific collection area (SCA) and is defined as the ratio of the total collection area to the total gas volume flow. The SCA can be changed by changing either the collection plate area or the gas volume flow or both. In effect, changes in SCA result in changes in the treatment time experienced by the particles. Thus, increasing the SCA of a precipitator increases the collection efficiency.

The SCA provides the most flexible variable in designing a precipitator. Although the SCA has practical limitations, it has no physical limitations and can be increased indefinitely. Even though a curve of efficiency versus SCA will level off for the larger values of SCA due to the exponential nature of the collection mechanism, greater efficiency can always be obtained from increased SCA.

The computer program for the model allows the user to easily examine the effects of SCA on precipitator performance by using a basic data set and shortened data sets. The SCA is changed by changing the gas volume flow and gas velocity through the precipitator and leaving the collection plate area fixed. It should be pointed out that for certain values of SCA this method of producing different SCAs will lead to impractical values of gas volume flow and gas velocity which are not physically meaningful. However, this approach is equivalent to changing the collection plate area in the present version of the model.

Table 14. INPUT DATA FOR EXAMPLE 7

```
                                        COLUMN NUMBER
 CARD             1         2         3         4         5         6         7         8
NUMBER   12345678901234567890123456789012345678901234567890123456789012345678901234567890

   1     1401
   2     LAB ESP: SCA=125FT2/1000ACFM;J=24UA/FT2;MMD=2UM;SIGMAP=2.5
   3     01020110100300010101 01
   4     05
   5     0.015     10.0      99.0      100.0     5.1       1.03      0.0001651.0     1500000.1.00E+09
   6     0.000.004.00
   7     0.10      0.30      0.50      0.70      0.90      1.10      2.90      5.10      6.90      9.10
   8     10.9      19.1      30.9      49.1
   9     2.0       2.5
  10     03030306
  11       6.2500E+00 4.6000E+04 1.5000E-04 6.2500E+00 4.6875E-02 5.0000E+00 5.0000E+00
  12       2.5000E+00 2.0000E+02 3.2000E+00 7.6800E+01 1.0000E+00 1.8000E-05 8.3333E-01
  13       6.2500E+00 4.5800E+04 1.5000E-04 6.2500E+00 4.6875E-02 5.0000E+00 5.0000E+00
  14       2.5000E+00 2.0000E+02 3.2000E+00 7.6800E+01 1.0000E+00 1.8000E-05 8.3333E-01
  15       1.2500E+01 4.4400E+04 3.0000E-04 1.2500E+01 4.6875E-02 5.0000E+00 1.0000E+01
  16       2.5000E+00 2.0000E+02 3.2000E+00 7.6800E+01 1.0000E+00 1.8000E-05 8.3333E-01
  17     1402
  18     LAB ESP: SCA=125FT2/1000ACFM;J=24UA/FT2;MMD=5UM;SIGMAP=2.5
  19     5.0       2.5
  20     1402
  21     LAB ESP: SCA=125FT2/1000ACFM;J=24UA/FT2;MMD=10UM;SIGMAP=2.5
  22     10.0      2.5
  23     1402
  24     LAB ESP: SCA=125FT2/1000ACFM;J=24UA/FT2;MMD=15UM;SIGMAP=2.5
  25     15.0      2.5
  26     1402
  27     LAB ESP: SCA=125FT2/1000ACFM;J=24UA/FT2;MMD=25UM;SIGMAP=2.5
  28     25.0      2.5
  29     1402
  30     LAB ESP: SCA=125FT2/1000ACFM;J=24UA/FT2;MMD=10UM;SIGMAP=1.5
  31     10.0      1.5
  32     1402
  33     LAB ESP: SCA=125FT2/1000ACFM;J=2UA/FT2;MMD=10UM;SIGMAP=5.0
  34     10.0      5.0
  35     1402
  36     LAB ESP: SCA=125FT2/1000ACFM;J=2UA/FT2;MMD=10UM;SIGMAP=10.0
  37     10.0      10.0
  38     1402
  39     LAB ESP: SCA=125FT2/1000ACFM;J=24UA/FT2;MMD=10UM;SIGMAP=15.0
  40     10.0      15.0
  41     99
```

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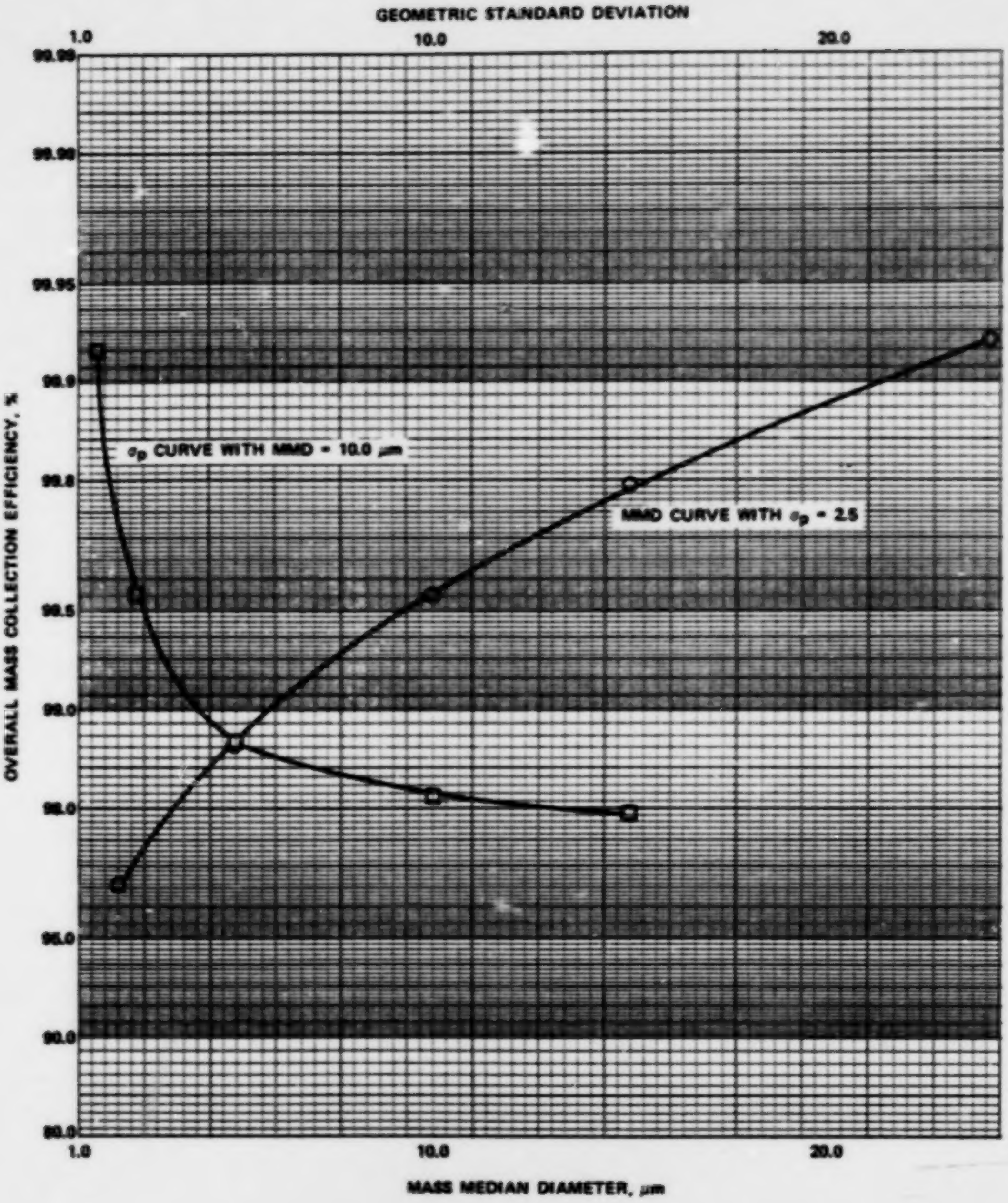

Figure 11. *Effect of particle size distribution on overall mass collection efficiency.*

Example 8

In this example, the effect of SCA on the overall mass collection efficiency is examined using the geometry and operating conditions in Example 1. Although the voltage-current characteristics will change with changes in SCA, it was assumed that they remained constant in order to obtain trends. If a more representative calculation is necessary, this can be provided by using the option which calculates voltage-current characteristics but this requires considerably more computer time. Overall mass collection efficiencies were determined for SCAs of 9.85, 39.4, 59.1, 78.7, 118.1, and 157.5 ($m^2/(m^3/sec)$) or 50, 200, 300, 400, 600, and 800 ($ft^2/(1000\ ft^3/min)$), respectively. The results obtained in Example 1 for an SCA of 24.6 ($m^2/(m^3/sec)$) or 125 ($ft^2/(1000\ ft^3/min)$) can also be used in this example. Table 15 gives the input data card set which was used to perform the calculations. The computation time required to run this example on the DEC 2020 computer was approximately 694 seconds.

Figure 12 shows curves of overall mass collection efficiency as a function of SCA that were obtained from the calculations. In obtaining the curves, the values of σ_g and S were taken to be zero. The output data from the computer program are given in Appendix H in abbreviated form.

These curves point out the large effect SCA has on precipitator performance. Also, two other features of interest should be discussed. First, the NO-RAP curve is significantly higher than the unadjusted, ideal curve. This is due to the fact that the inlet particle size distribution (MMD = 4 μm) is weighted towards the fine particle size range where the correction factors to the NO-RAP migration velocities are applied. As the MMD of the inlet particle size distribution increases, the NO-RAP curve and the unadjusted, ideal curve come into better agreement. Second, the detrimental effect rapping reentrainment can have on precipitator performance is clearly seen. Even with good electrical operating conditions (45.2 kV and 25.8 nA/cm^2), high collection efficiencies are difficult to achieve with typical losses in collection efficiency due to rapping reentrainment without going to large values of SCA. From the curves, an overall mass collection efficiency of 99.9% can be obtained at an SCA of 49.25 $m^2/(m^3/sec)$ or 250 $ft^2/(1000\ ft^3/min)$. However, with rapping, an SCA of 78.7 $m^2/(m^3/sec)$ or 400 $ft^2/(1000\ ft^3/min)$ is required in order to obtain the same overall mass collection efficiency. With worse electrical operating conditions, the effects of rapping reentrainment would be even more severe due to the collection of more mass on the outlet fields of the precipitator.

EFFECT OF APPLIED VOLTAGE AND CURRENT DENSITY

In practice, it is desirable to operate a precipitator at the highest values of applied voltage and current density that can be

Table 15. INPUT DATA FOR EXAMPLE 8

```
                                               COLUMN NUMBER
  CARD             1         2         3         4         5         6         7         8
 NUMBER   12345678901234567890123456789012345678901234567890123456789012345678901234567890

    1     1601
    2     LAB ESP: SCA=50FT2/1000ACFM;J=24UA/FT2
    3     0101011010030001010101
    4     05
    5     0.015   10.0    99.0    1000.0  5.1     1.03    0.0001651.0     1500000.1.00E+09
    6     0.000.004.00
    7     0.20    0.30    0.40    0.50    0.60    0.80    1.00    1.20    1.40    1.80
    8     2.20    3.00    4.00    6.00    10.0    20.0
    9     0.0     0.0002  0.4002  1.0002  2.6672  7.6672  12.6002 17.3332 21.3332 29.3332
   10     36.0002 46.6672 57.3342 68.6672 80.6672 100.0
   11     03030306
   12      6.2500E+00 4.6000E+04 1.5000E-04 6.2500E+00 4.6875E-02 5.0000E+00 5.0000E+00
   13      2.5000E+00 5.0000E+02 8.0000E+00 7.6800E+01 1.0000E+00 1.8000E-05 8.3333E-01
   14      6.2500E+00 4.5800E+04 1.5000E-04 6.2500E+00 4.6875E-02 5.0000E+00 5.0000E+00
   15      2.5000E+00 5.0000E+02 8.0000E+00 7.6800E+01 1.0000E+00 1.8000E-05 8.3333E-01
   16      1.2500E+01 4.4400E+04 3.0000E-04 1.2500E+01 4.6875E-02 5.0000E+00 1.0000E+01
   17      2.5000E+00 5.0000E+02 8.0000E+00 7.6800E+01 1.0000E+00 1.8000E-05 8.3333E-01
   18     1603
   19     LAB ESP: SCA=200FT2/1000ACFM;J=24UA/FT2
   20      1.2500E+02 2.0000E+00 1.2500E+02 2.0000E+00 1.2500E+02 2.0000E+00
   21     1603
   22     LAB ESP: SCA=300FT2/1000ACFM;J=24UA/FT2
   23      8.3333E+01 1.3333E+00 8.3333E+01 1.3333E+00 8.3333E+01 1.3333E+00
   24     1603
   25     LAB ESP: SCA=400FT2/1000ACFM;J=24UA/FT2
   26      6.2500E+01 1.0000E+00 6.2500E+01 1.0000E+00 6.2500E+01 1.0000E+00
   27     1603
   28     LAB ESP: SCA=600FT2/1000ACFM;J=24UA/FT2
   29      4.1667E+01 6.6667E-01 4.1667E+01 6.6667E-01 4.1667E+01 6.6667E-01
   30     1603
   31     LAB ESP: SCA=800FT2/1000ACFM;J=24UA/FT2
   32      3.1250E+01 5.0000E-01 3.1250E+01 5.0000E-01 3.1250E+01 5.0000E-01
   33     99
```

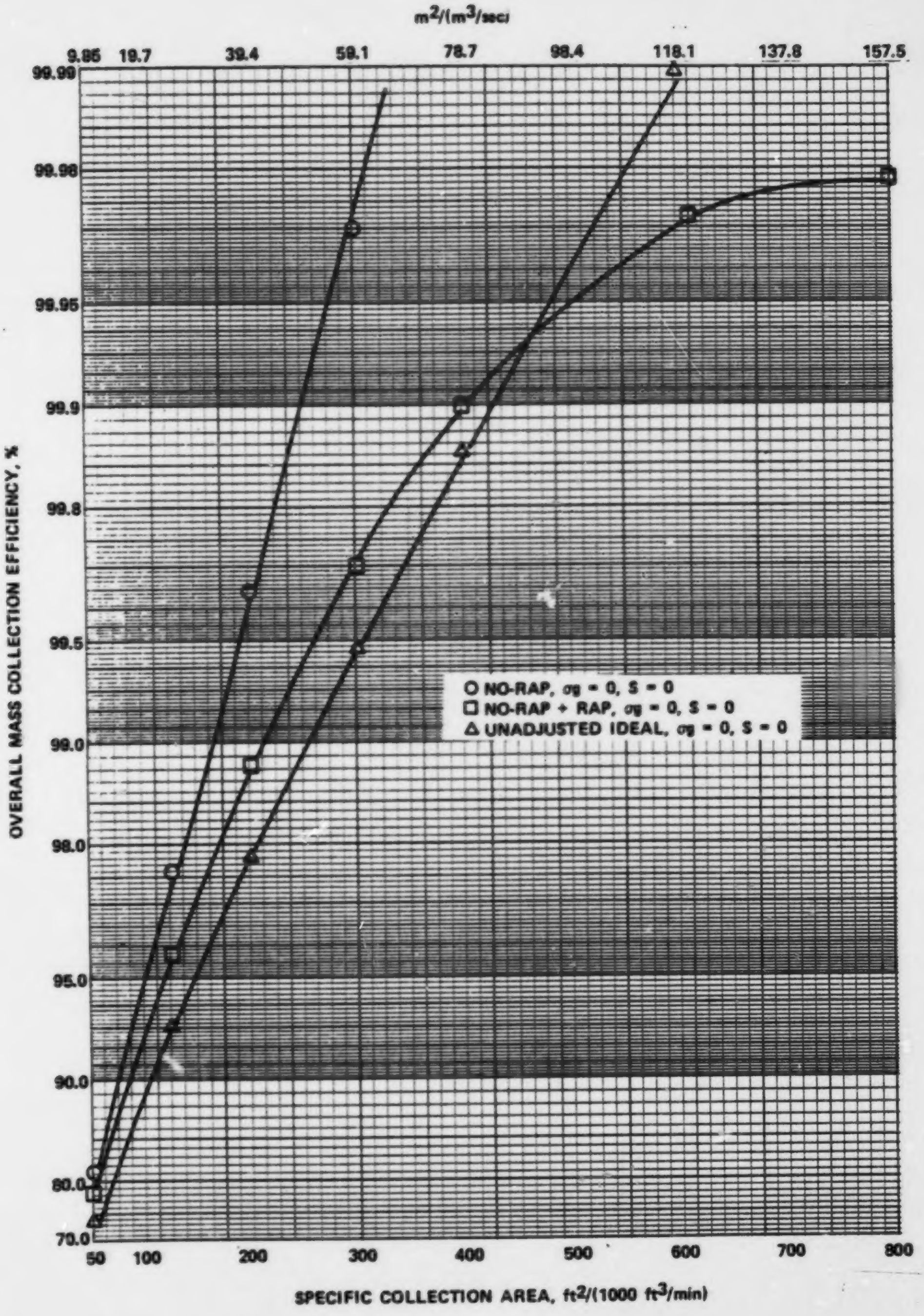

Figure 12. *Effect of specific collection area on overall mass collection efficiency.*

obtained without excessive sparking or back corona. Higher values of applied voltage lead to higher electric fields which result in increased particle charge and a higher value of the electric field near the collection electrode. Higher values of current density lead to higher ion densities which result in faster charging rates and an increased contribution to the total electric field near the collection electrode due to space charge. Thus, higher values of applied voltage and current density lead to higher migration velocities and higher collection efficiencies.

In analyzing the effects of applied voltage and current density with the model, it must be realized that the values of applied voltage and current density are limited by the onset of sparking or back corona which is not predicted by the model in its present form. Also, for the geometries which are used in practice, the voltage-current curve becomes very steep for higher applied voltages and large increases in current can be obtained from small increases in applied voltage. For precipitators operating with voltages and currents on the steep portion of the voltage-current curve, increasing the current will not have a very pronounced effect on improving precipitator performance because only small changes in applied voltage will be realized and the applied voltage plays the dominant role in limiting particle charge and controlling the electric field.

The computer program for the model allows the user to easily examine the effects of applied voltage and current density on precipitator performance by using a basic data set and shortened data sets. Measured or known values of applied voltage and current density can be supplied by the user or theoretical values can be determined for wire-plate geometries.

Example 9

In this example, the effect of applied voltage and current density on the overall mass collection efficiency is examined using the geometry and operating conditions in Example 1. Figure 13 shows the voltage-current curves for the three electrical sections where particles are in the gas stream. These curves were used in order to determine various applied voltages and current densities. The overall mass collection efficiency was determined for 2, 5, 10, 20, 35, and 45 nA/cm^2. The results obtained in Example 1 for 25.8 nA/cm^2 can also be used in this example. Table 16 gives the input data card set which was used to perform the calculations. The computation time required to run this example on the DEC 2020 computer was approximately 795 seconds.

Figure 14 shows curves of overall mass collection efficiency as a function of average current density at the plate that were obtained from the calculations. In obtaining the curves, the values of σ_g and S were taken to be zero. The output data from the computer program are given in Appendix I in abbreviated form.

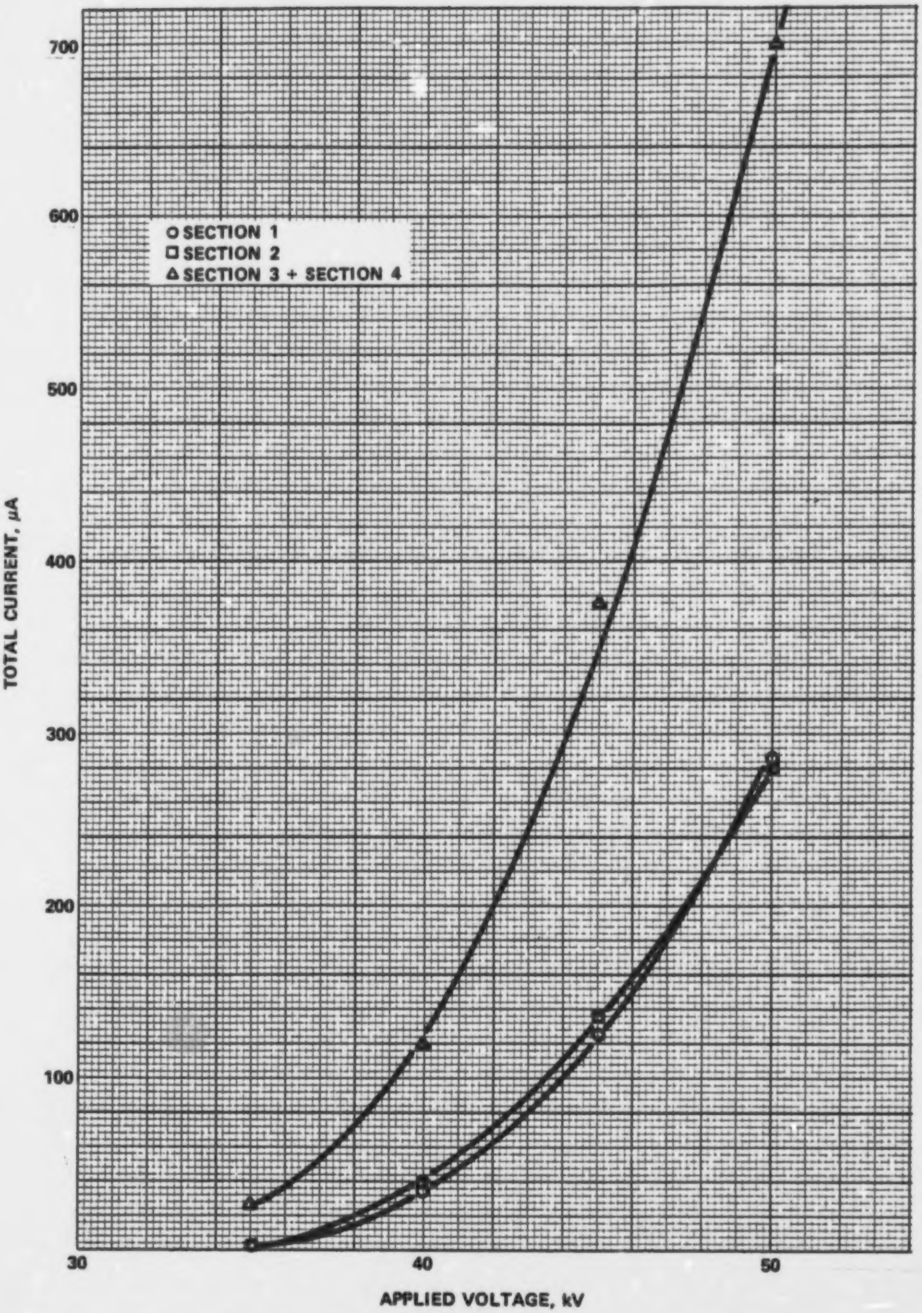

Figure 13. *Experimental voltage-current curves used in Example 7.*

Table 16. INPUT DATA FOR EXAMPLE 9

```
                                    COLUMN NUMBER
 CARD            1         2         3         4         5         6         7         8
NUMBER  12345678901234567890123456789012345678901234567890123456789012345678901234567890

   1    1601
   2    LAB ESP: SCA=125FT2/1000ACFM;J=2 NA/CM2
   3    01010110100300010101 01
   4    05
   5    0.015   10.0    99.0    1000.0  5.1     1.03    0.0001651.0     1500000.1.00E+09
   6    0.000.004.000.100.104.00
   7    0.20    0.30    0.40    0.50    0.60    0.80    1.00    1.20    1.40    1.80
   8    2.20    3.00    4.00    6.00    10.0    20.0
   9    0.0     0.0002  0.4002  1.0002  2.6672  7.6672  12.6002 17.3332 21.3332 29.3332
  10    36.0002 46.6672 57.3342 68.6672 80.6672 100.0
  11    03030306
  12     6.2500E+00 3.7500E+04 1.1628E-05 6.2500E+00 4.6875E-02 5.0000E+00 5.0000E+00
  13     2.5000E+00 2.0000E+02 3.2000E+00 7.6800E+01 1.0000E+00 1.8000E-05 8.3333E-01
  14     6.2500E+00 3.7000E+04 1.1628E-05 6.2500E+00 4.6875E-02 5.0000E+00 5.0000E+00
  15     2.5000E+00 2.0000E+02 3.2000E+00 7.6800E+01 1.0000E+00 1.8000E-05 8.3333E-01
  16     1.2500E+01 3.4900E+04 2.3256E-05 1.2500E+01 4.6875E-02 5.0000E+00 1.0000E+01
  17     2.5000E+00 2.0000E+02 3.2000E+00 7.6800E+01 1.0000E+00 1.8000E-05 8.3333E-01
  18    1604
  19    LAB ESP: SCA=125FT2/1000ACFM;J=5 NA/CM2
  20     3.9450E+04 2.9070E-05 3.9000E+04 2.9070E-05 3.7200E+04 5.8140E-05
  21    1604
  22    LAB ESP: SCA=125FT2/1000ACFM;J=10 NA/CM2
  23     4.1600E+04 5.8140E-05 4.1200E+04 5.8140E-05 3.9800E+04 1.1628E-04
  24    1604
  25    LAB ESP: SCA=125FT2/1000SCFM;J=20 NA/CM2
  26     4.4700E+04 1.1628E-04 4.4400E+04 1.1628E-04 4.3000E+04 2.3256E-04
  27    1604
  28    LAB ESP: SCA=125FT2/1000SCFM;J=35 NA/CM2
  29     4.7800E+04 2.0349E-04 4.7800E+04 2.0349E-04 4.6600E+04 4.0698E-04
  30    1604
  31    LAB ESP: SCA=125FT2/1000SCFM;J=45 NA/CM2
  32     4.9400E+04 2.6163E-04 4.9400E+04 2.6163E-04 4.7600E+04 5.2326E-04
  33    99
```

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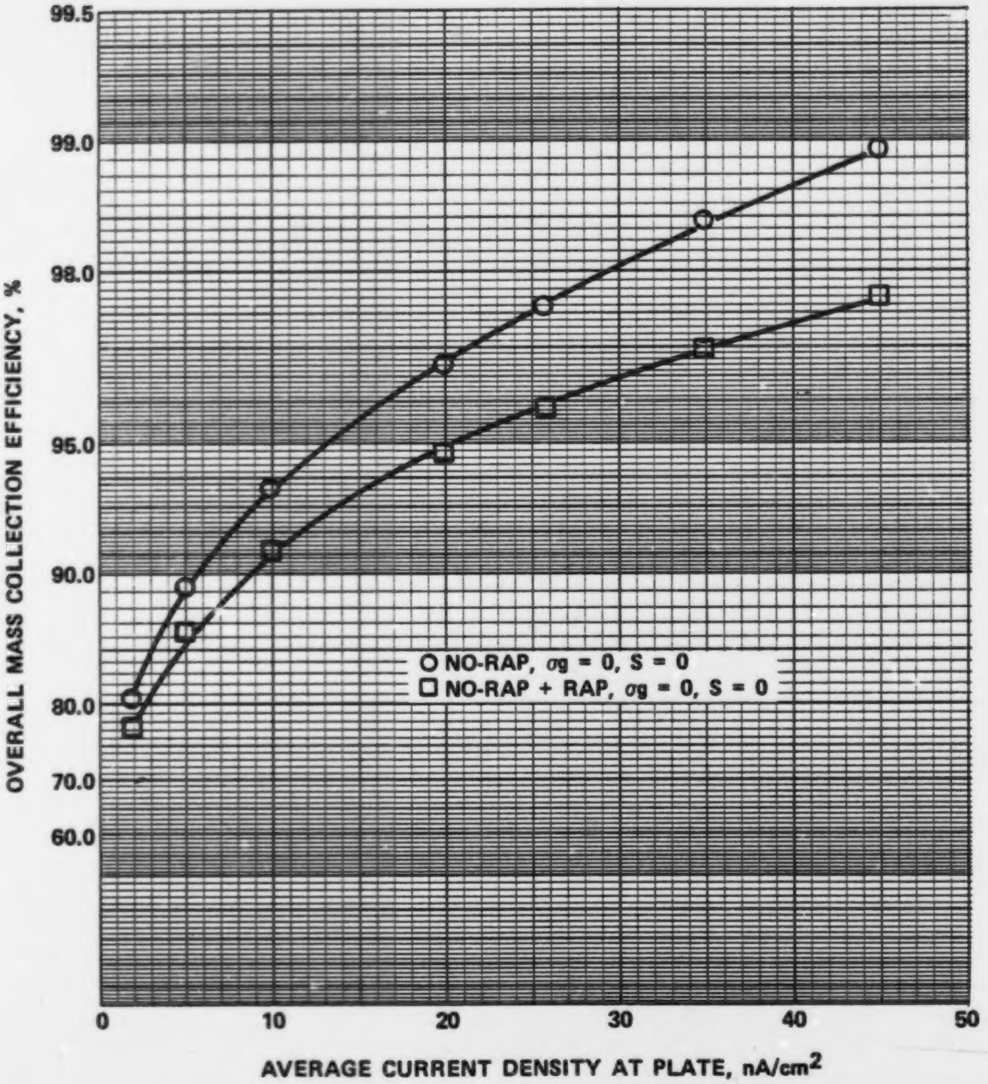

Figure 14. *Effect of current density on overall mass collection efficiency.*

Comparison of Figures 12 and 14 show that overall mass collection efficiency varies more slowly with current density than with specific collection area. The curves in Figure 14 show that if the precipitator is operated at low values of current density, then significantly reduced overall mass collection efficiencies will result. Thus, in designing a precipitator, the effect of possible changes in the allowable current density due to changes in the material being collected must be taken into account. If reduced current densities are a possibility, then the possible reduction in collection efficiency must be compensated for by an excess in specific collection area (or, more appropriately, collection plate area). The curves in Figure 13 also show that more mass will exit the precipitator due to rapping reentrainment for the lower values of current density than the higher values. At 2 nA/cm^2, the model predicts that approximately 3.1% of the mass entering the precipitator will exit due to rapping reentrainment whereas, at 45 nA/cm^2, approximately 1.3% of the mass entering the precipitator will exit due to rapping reentrainment. Thus, when considering the effect of reductions in current density on precipitator performance, one must take into account not only fundamental reductions in collection efficiency due to lowered migration velocities but also possible increased reductions due to increased rapping reentrainment.

EFFECT OF NONIDEAL CONDITIONS

The effects on precipitator performance of nonuniform gas velocity distribution, gas bypassage of electrified regions, and particle reentrainment must be considered in simulating the operation of an existing precipitator or in designing a new precipitator. In many instances, poor performance of a precipitator can be traced to either one or a combination of these nonideal conditions. Although these nonideal conditions can not be completely avoided, their effects should be minimized in order to achieve good performance. The normalized standard deviation of the gas velocity distribution should have a value of 0.25 or less. The fraction per baffled section of gas bypassage and/or collected mass reentrained without rapping should have a value of 0.1 or less. In order to obtain high efficiencies, the number of baffled sections should be at least four. Testing should be performed in order to optimize the rapping intensity and schedule and to minimize the amount of mass which is reentrained.

The computer program for the model allows the user to easily examine the effects of various nonideal conditions on precipitator performance with one basic data set. The effect of up to 10 different log-normal "rapping puff" particle size distributions can be analyzed for a given set of precipitator parameters by designating the MMD and σ_p for each. For each "rapping puff" particle size distribution, the effect of up to 15 different combinations of σ_g and S on the no-rap and no-rap + rap performance can be obtained. The maximum amount of information concerning nonideal conditions can be obtained with little additional use of computer time.

Example 10

In this example, the effect of various sets of nonideal conditions on the overall mass collection efficiency is examined using the geometry and operating conditions in Example 3. In addition, the operating current density in each electrical section is theoretically determined by generating a clean-gas, voltage-current curve for the first electrical section only and holding the applied voltage fixed in each electrical section at the average value of 41.6 kV. In order to speed up the calculations, particle charge is determined by using the sum of the charges from classical field and diffusional charging theories.

The effect on overall mass collection efficiency of nine different log-normal "rapping puff" particle size distributions was obtained by specifying eight pairs (MMD, σ_p) of MMD and σ_p along with the values (6.0, 2.5) stored in the program. The eight pairs had values of (2.0, 2.5), (10.0, 2.5), (15.0, 2.5), (20.0, 2.5), (10.0, 1.5), (10.0, 5.0), (10.0, 10.0), and (10.0, 15.0). The effect on overall mass collection efficiency of nine different pairs (S, σ_g) of S and σ_g was also obtained for (0.00, 0.00), (0.10, 0.25), (0.30, 0.25), (0.50, 0.25), (0.70, 0.25), (0.10, 0.10), (0.10, 0.40), (0.10, 0.60), and (0.10, 0.80). Table 17 gives the input data card set which was used to perform the calculations. The computation time required to run this example on the DEC 2020 computer was approximately 479 seconds. Excerpts from the output data from the computer program are given in Appendix J.

An effective ion mobility of 2.7 x 10^{-4} m^2/V-sec and a roughness factor of 0.85 were used in the calculations which predict the voltage-current characteristics and the electrical operating conditions. Using these parameters, the average current densities at the plate in successive electrical sections were calculated to be 12.6, 18.3, and 23.2 nA/cm^2. These compare with the measured values of current density of 11.1, 17.6, and 22.7 nA/cm^2, respectively, that were obtained at applied voltages of 40.6, 42.1, and 42.45 kV, respectively. The collection efficiencies predicted here are somewhat less than those predicted in Example 3 due to the factors already discussed in Example 2.

The curves shown in Figure 15 point out the importance of careful mechanical design and optimization of gas flow properties. As these curves show, severe nonuniformity of the gas velocity distribution and/or a large degree of gas sneakage will result in serious degradation of precipitator performance. Figures 16 and 17 demonstrate the effect that the particle size distribution of the material reentrained due to rapping can have on the particle size distribution of the total emissions at the outlet of the precipitator when $\sigma_g = 0.25$ and S = 0.1. In obtaining the curves shown in these figures, the total mass at the outlet due to rapping reentrainment has been held fixed and only the particle size distribution of the "rapping puff" has been varied. Thus,

Table 17. INPUT DATA FOR EXAMPLE 10

```
                                      COLUMN NUMBER
 CARD             1         2         3         4         5         6         7         8
NUMBER   12345678901234567890123456789012345678901234567890123456789012345678901234567890

   1     1401
   2     PLANT A: SCA=243FT2/1000ACFM;VO=41.7KV;CALC. V-I;ANALYSIS OF NONIDEAL EFFECTS
   3     01010215150101090101O9
   4     2002200101
   5     1.966   27.0    99.6    2270.0  100.0   1.2     0.00027 1.0     1500000.5.00E+10
   6     2.002.5010.02.5015.02.5020.02.5010.01.5010.05.0010.010.010.015.0
   7     0.000.004.000.100.254.000.300.254.000.500.254.000.700.254.000.100.104.00
   8     0.100.404.000.100.604.000.100.804.00
   9     0.10    0.30    0.50    0.90    1.30    1.90    3.10    3.90    5.10    6.90
  10     10.1    14.9    25.1    29.9
  11     0.0     0.033   0.286   1.189   2.004   3.524   7.048   8.70    10.352  12.334
  12     15.638  20.484  32.599  100.0
  13     03151515
  14     +2.6460E+04+4.1700E+04+2.7300E-01+1.5720E+04+8.2500E-02+5.5000E+00+1.2000E+01
  15     +3.6000E+00+3.2724E+05+4.1000E+00+3.1500E+02+1.0000E+00+2.2900E-05+6.0000E-01
  16     +8.5000E-01+1.0000E-04+5.0000E-05+5.0000E-05+3.6000E+04
  17     +2.6460E+04+4.1700E+04+2.7300E-01+1.5720E+04+8.2500E-02+5.5000E+00+1.2000E+01
  18     +3.6000E+00+3.2724E+05+4.1000E+00+3.1500E+02+1.0000E+00+2.2900E-05+6.0000E-01
  19     +8.5000E-01+1.0000E-04+5.0000E-05+5.0000E-05+3.6000E+04
  20     +2.6460E+04+4.1700E+04+2.7300E-01+1.5720E+04+8.2500E-02+5.5000E+00+1.2000E+01
  21     +3.6000E+00+3.2724E+05+4.1000E+00+3.1500E+02+1.0000E+00+2.2900E-05+6.0000E-01
  22     +8.5000E-01+1.0000E-04+5.0000E-05+5.0000E-05+3.6000E+04
  23     99
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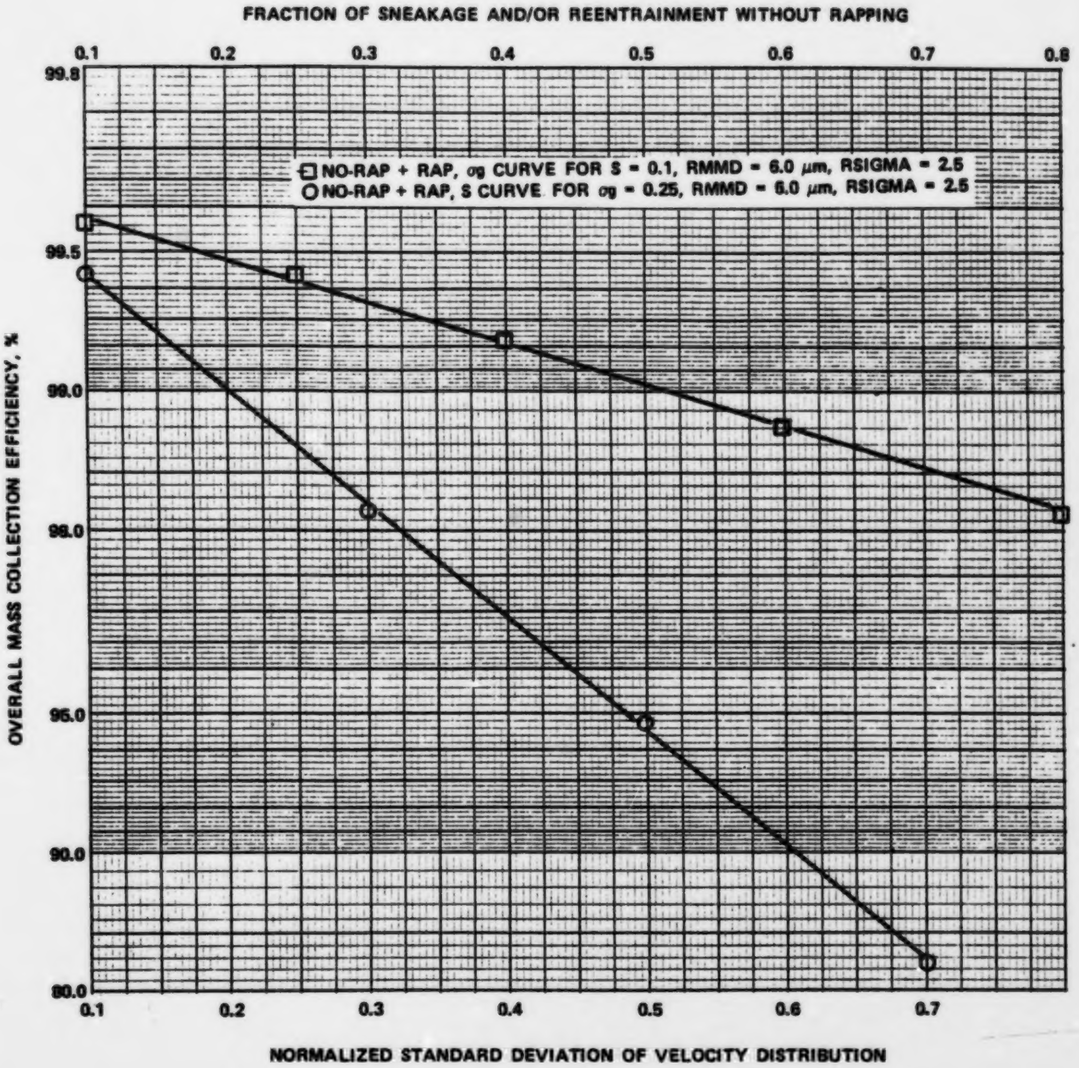

Figure 15. *Effects of nonideal conditions on overall mass collection efficiency.*

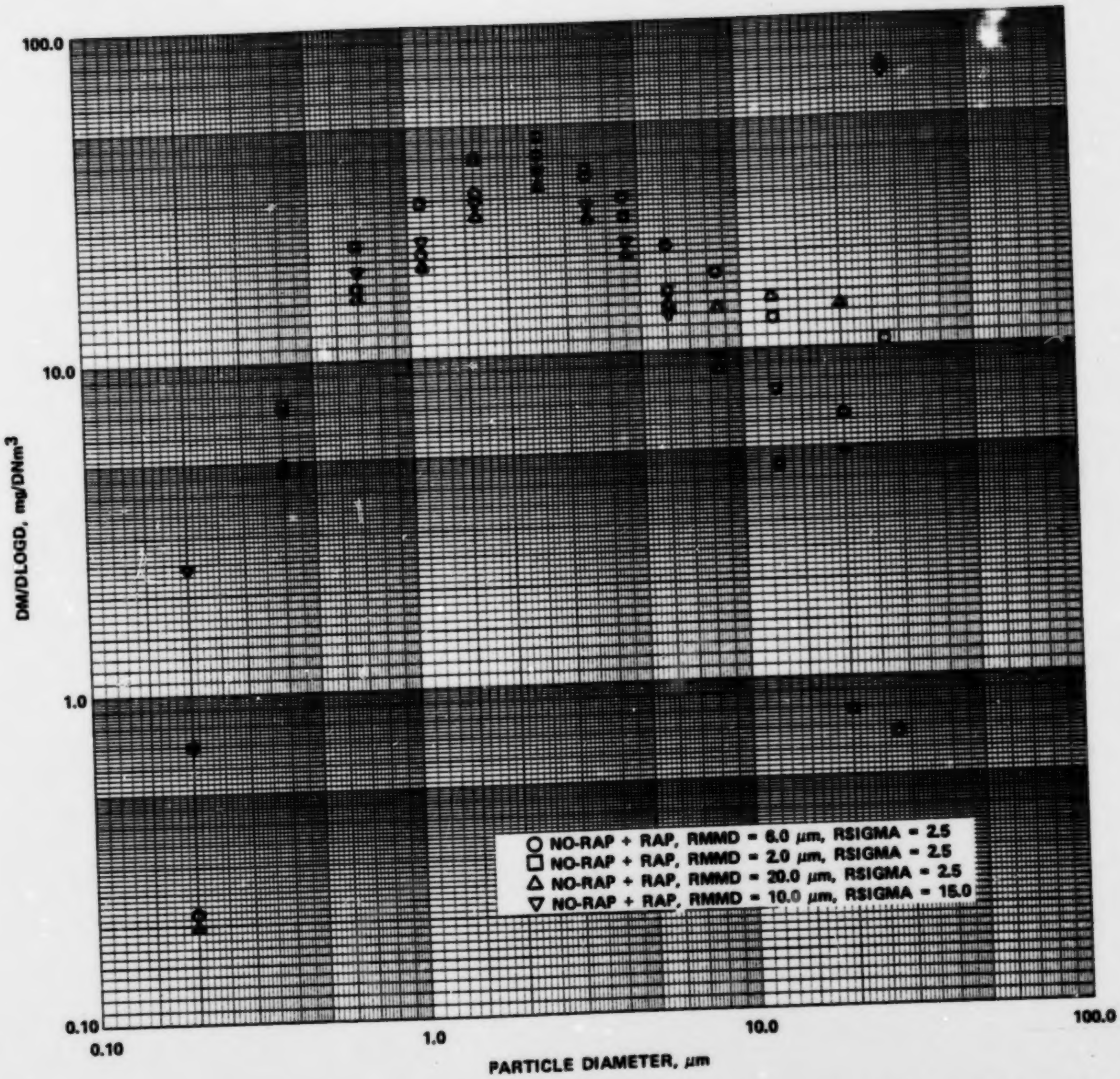

Figure 16. *Distribution of mass in the total outlet emission for different particle size distributions in the 'rapping puff'.*

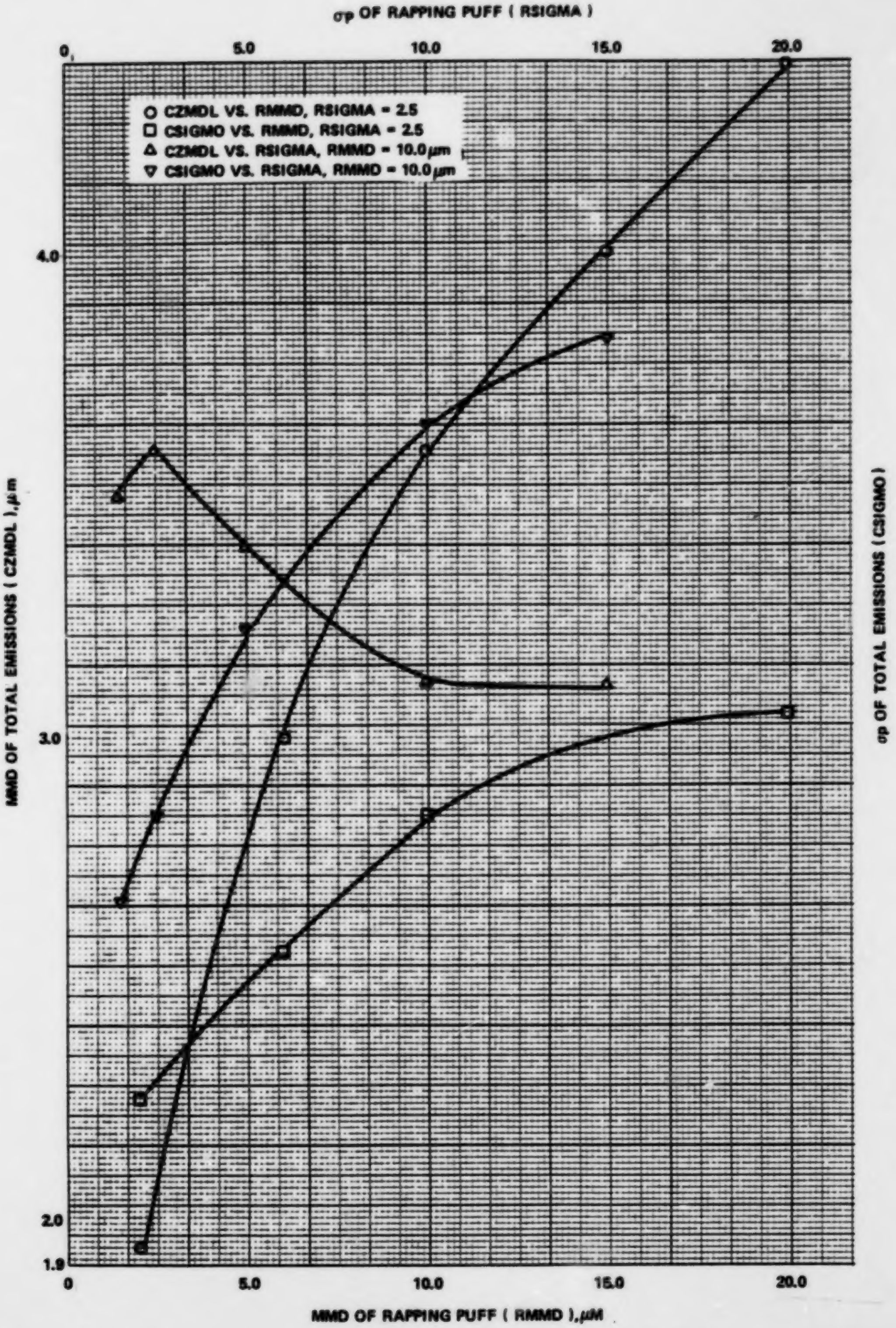

Figure 17. *Effects of the 'rapping puff' particle size distribution on the particle size distribution of the total emmissions.*

the overall mass collection efficiency remains the same but the particle size distribution at the outlet varies. This type of analysis is important when the opacity due to the outlet emissions is of interest since the opacity will depend on the amount and the particle size distribution of the mass exiting the precipitator. In certain cases, the outlet mass standard can be met with the opacity being far out of compliance. For these cases, the quantity and particle size distribution of the mass due to rapping reentrainment is very important in determining the opacity. Figure 16 shows the distribution of mass in the total outlet emissions for different particle size distributions in the "rapping puff". Depending on the resulting MMD and σ_p, these changes in the distribution of mass in the outlet emissions can have a significant effect on the opacity. Figure 17 shows several curves which demonstrate the effect that the "rapping puff" particle size distribution can have on the particle size distribution of the total emissions. These possible shifts in MMD and σ_p of the outlet emissions due to rapping reentrainment are large enough to produce significant changes in opacity.

EFFECT OF RESISTIVITY

In many instances, the useful operating current density in a precipitator is limited by the resistivity of the collected particulate layer. If the resistivity of the collected particulate layer is sufficiently high, electrical breakdown of the layer will occur at a value of current density which in most cases is undesirably low. Depending on the value of the applied voltage, the breakdown of the collected particulate layer will result in either a condition of sparking or the formation of stable back corona from points on the particulate layer. Excessive sparking and back corona are detrimental to precipitator performance and should be avoided.

Figure 1 shows an experimentally determined relationship between maximum allowable current density and resistivity.* It points out the severe drop in maximum allowable current density as the resistivity increases over the range 0.5 - 5.0 x 10^{11} ohm-cm. With Figure 1 and known or calculated voltage-current characteristics, the effect of resistivity on the overall mass collection efficiency that can be obtained for a fixed geometry and specific collection area can be determined by using the mathematical model of electrostatic precipitation.

Example 11

Once the overall mass collection efficiency is determined as a function of current density for a given precipitator geometry and specific collection area, then the performance of the precipitator can easily be determined as a function of resistivity. In this example, the results from Example 9 and Figure 1 are used to illustrate the effect that the resistivity of the collected particulate layer can have on the performance of a given precipitator. Figure 1 shows the effect that resistivity would have on the overall mass collection efficiency for the precipitator and conditions in Example 9. In obtaining the curves, resistivities of 0.2, 0.26, 0.35, 0.45, 0.90, 1.8, and 4.5 (x 10^{11} ohm-cm) were taken to limit maximum allowable current densities to values of 45.0, 35.0, 25.8, 20.0, 10.0, 5.0, and 2.0 nA/cm^2, respectively.

The curves in Figure 18 show the dramatic effect that changes in resistivity can have on precipitator performance. If we assume that the precipitator in this example is operating under the most favorable electrical conditions possible, the NO-RAP overall mass collection efficiency would drop from 98.8% to 80.8% if the resistivity of the collected particulate layer increased from 2 x 10^{10} to 4.5 x 10^{11} ohm-cm. This example points out why a knowledge of the resistivity of the collected particulate layer is crucial in designing a precipitator. The problem is made even more difficult since the resistivity can change significantly with changes in the composition, moisture content, and temperature of the flue gas. In addition, changes in resistivity due to changes in the material producing the emissions must also be considered. Thus, in designing a precipitator, proper allowance must be made to account for possible values of resistivity that are larger than that anticipated.

USE OF THE ESTIMATION PROCEDURE

The mathematical model of electrostatic precipitation provides the option of using an estimation procedure to predict precipitator performance. When only gross trends are desired or a starting point for the more rigorous calculation is needed, the use of this option can save considerable amounts of computer time. The details of the estimation procedure are presented in Volume 1 and will not be discussed here. If a user plans to make extensive use of the estimation procedure, he should refer to Volume 1 in order to acquire an understanding of the basis for the procedure. Although judicious use of the estimation procedure can be quite beneficial to the user, it can not be assumed that predictions from this procedure will always be close to those of the more rigorous calculation. Thus, all final simulations and final designs should be obtained by using the more rigorous calculation.

Example 12

In this example, the operation of the hot-side precipitator in Example 4 is simulated using the estimation procedure. Table 18 gives the input data card set which was used to perform the calculations. The computation time required to run this example on the DEC 2020 computer was approximately 15 seconds. In this case, the estimation procedure runs 15 times as fast as

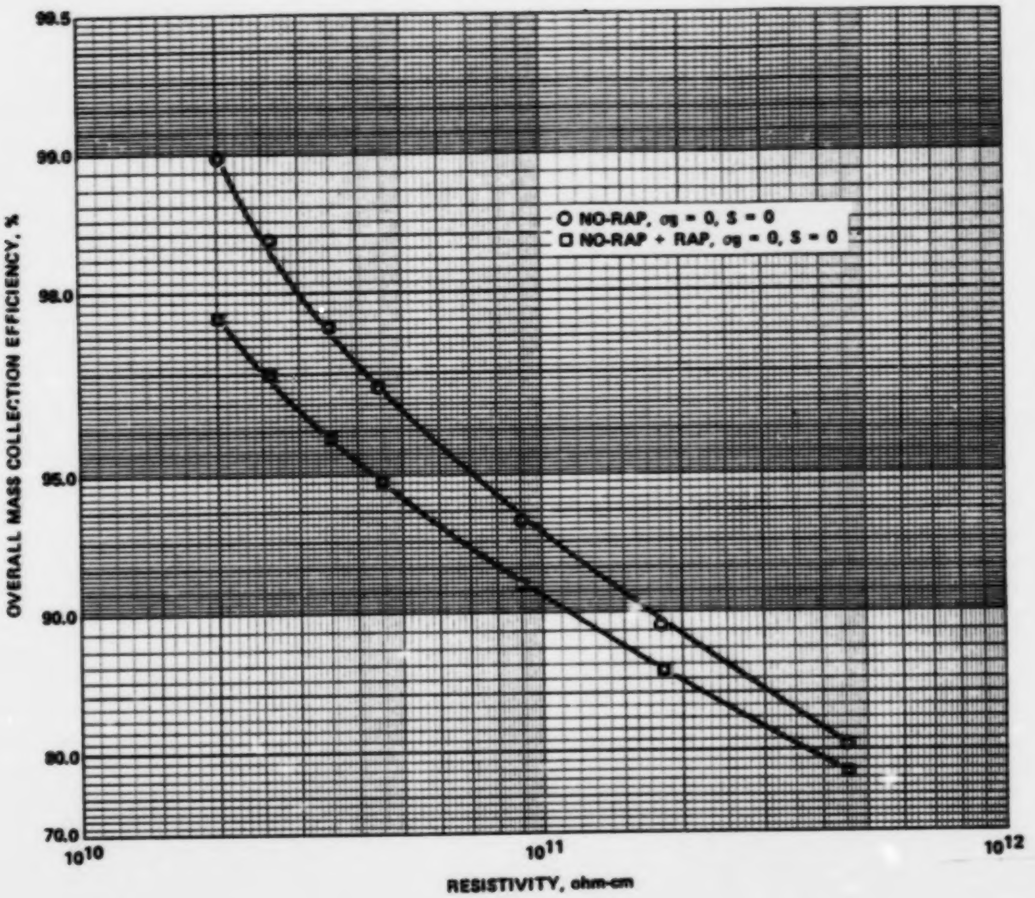

Figure 18. Effect of resistivity on overall mass collection efficiency.

Table 18. INPUT DATA FOR EXAMPLE 12

```
                                COLUMN NUMBER
CARD               1         2         3         4         5         6         7         8
NUMBER    12345678901234567890123456789012345678901234567890123456789012345678901234567890

 1        1501
 2        FULL-SCALE,HOT-SIDE ESP: PLANT B;SCA=390FT2/1000ACFM;J=34.3UA/FT2;EST. PROCED.
 3        020101101003010101020
 4        2.51    36.0    99.6    2270.0  100.0   1.2     0.00022 1.0     1500000.1.90E+10
 5        0.000.004.000.100.254.00
 6        0.20    0.40    0.70    1.00    1.50    2.00    3.00    4.00    5.00    7.00
 7        10.00   15.00   25.00   30.0    100.0
 8        0.0     0.1479  0.57421 1.00922 1.72264 2.74926 6.52514 9.48321 11.1362513.05029
 9        15.6255520.1844530.9726935.49679100.0
10        0409090909
11        +4.2120E+04+3.5880E+04+1.2200E+00+5.6160E+04+5.4500E-02+4.5000E+00+1.2000E+01
12        +4.5000E+00+4.3207E+05+3.7958E+00+6.2400E+02+1.0000E+00+2.8000E-05+1.0000E+00
13        +4.2120E+04+3.3950E+04+1.6720E+00+5.6160E+04+5.4500E-02+4.5000E+00+1.2000E+01
14        +4.5000E+00+4.3207E+05+3.7958E+00+6.2400E+02+1.0000E+00+2.8000E-05+1.0000E+00
15        +4.2120E+04+2.9130E+04+1.4200E+00+5.6160E+04+5.4500E-02+4.5000E+00+1.2000E+01
16        +4.5000E+00+4.3207E+05+3.7958E+00+6.2400E+02+1.0000E+00+2.8000E-05+1.0000E+00
17        +4.2120E+04+2.7500E+04+1.4600E+00+5.6160E+04+5.4500E-02+4.5000E+00+1.2000E+01
18        +4.5000E+00+4.3207E+05+3.7958E+00+6.2400E+02+1.0000E+00+2.8000E-05+1.0000E+00
19        99
```

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the more rigorous calculation. The output data from the computer program are given in Appendix K.

For this example, the prediction of overall mass collection efficiency by the estimation procedure is essentially the same as that obtained from the more rigorous calculation. Figure 19 shows a comparison of the fractional collection efficiencies and migration velocities obtained from the two methods of calculation. Although slight differences exist in the predicted fractional collection efficiencies, even significantly different inlet particle size distributions would not lead to any appreciable disagreement in overall mass collection efficiencies predicted from the two methods of calculation. The good agreement between the estimation procedure and the rigorous calculation can be attributed to the agreement in the values of the electric field at the plate. For the rigorous calculation, the values of average electric field at the plate in successive electrical sections are 1.70, 1.72, 1.53, and 1.51 (x 10^5 V/m) whereas, for the estimation procedure, the corresponding values are 1.79, 1.70, 1.46, and 1.38 (x 10^5 V/cm), respectively. The estimated values of the electric field at the plate provide the greatest uncertainty in the estimation procedure and the type of agreement obtained in this example can not always be expected.

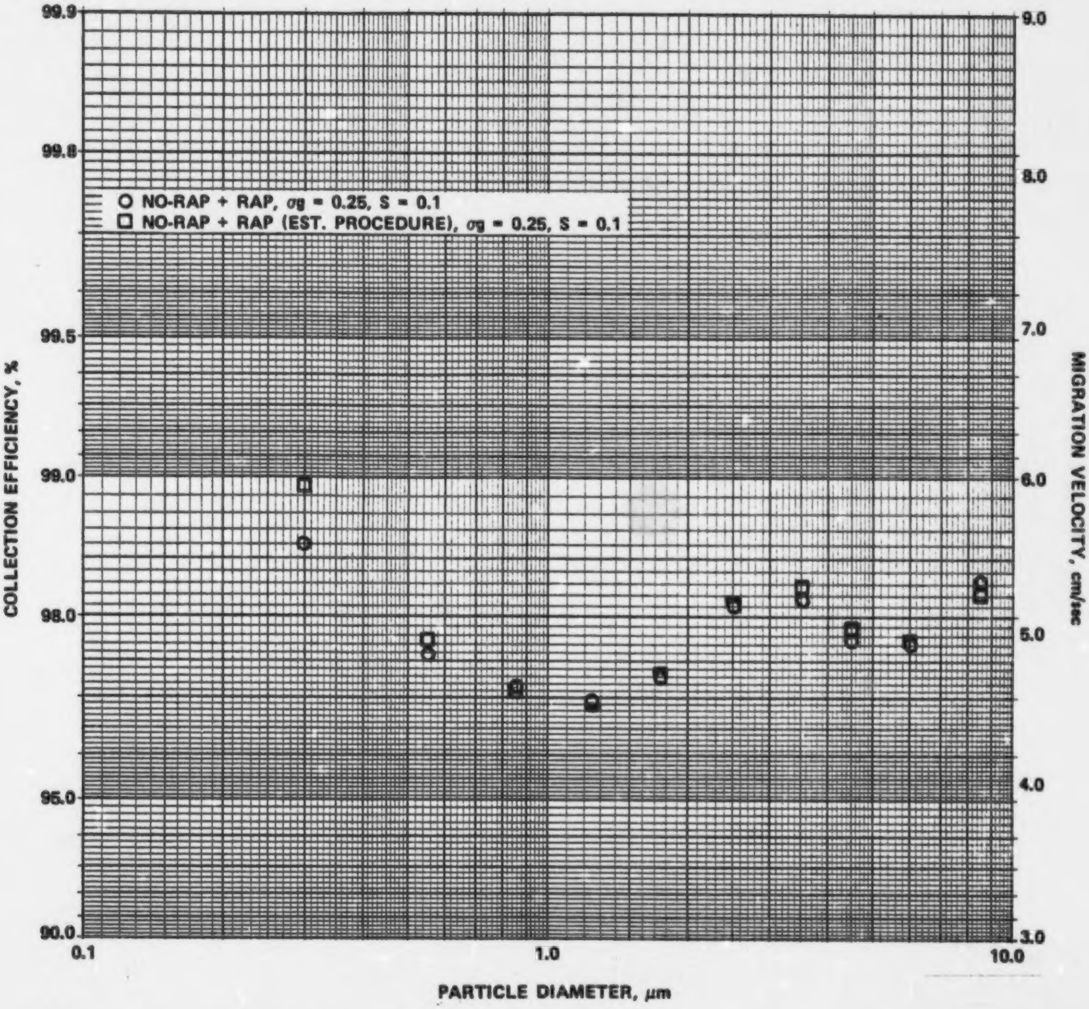

Figure 19. Comparison of results obtained form rigorous application of the model and the estimation procedure.

SECTION 11

USE OF THE MODEL FOR TROUBLESHOOTING

The mathematical model of electrostatic precipitation can be used as a tool in troubleshooting precipitators that are not meeting the overall mass collection efficiency which is expected or anticipated. When using the model for troubleshooting, certain experimental data should be obtained in order to properly utilize the model. These data include operating voltages and currents in the different electrical sections, inlet mass loading and particle size distribution, ash resistivity, average gas flow rate and velocity, and average gas temperature and pressure. By using these limited experimental data, the geometry of the precipitator, and the mathematical model, certain steps which are given below can be taken in an attempt to diagnose the possible reason or reasons for the level of performance of the precipitator.

Step 1: Determine optimum collection efficiency.

Use the model to simulate the operation of the precipitator under ideal, no-rap conditions ($\sigma_g = 0$ and $S = 0$) with the actual operating parameters. This calculation establishes the optimum overall mass collection efficiency that can be expected under the given operating conditions. It should be noted that this optimum efficiency may not always represent the best performance of the precipitator since accumulation of material on the discharge and collection electrodes, broken discharge electrodes, electrode misalignment, or operation of the precipitator at lower than permissible voltages and currents would result in less than optimum electrical operating conditions. If possible, measures should be taken to ensure that the electrical conditions in the precipitator are at their best when obtaining data for use in the troubleshooting procedure. In any event, the starting point in the troubleshooting procedure can be taken to be the calculated optimum efficiency under the actual operating conditions.

Step 2: Check to see if the calculated optimum efficiency is equal to or less than the measured value.

If the calculated optimum value of efficiency is equal to or less than the measured value, the precipitator can be assumed to be performing as well as possible for the given set of operating conditions. Changes in the inlet particle size distribution, the electrical operating conditions, or the gas volume flow can result in a reduction in collection efficiency for a given precipitator even though the precipitator is performing at its best. Thus, in certain cases, a precipitator may not be able to attain the overall mass collection efficiency it once achieved or was designed to achieve solely due to a change in the process variables. As a consequence, the precipitator may no longer be sized properly for the operating conditions encountered. The options that are available for improving the performance of the precipitator are limited to the possible improvement of the electrical operating conditions or a reduction in the gas flow rate through the precipitator.

Step 3: Check to see if the calculated optimum efficiency is only a little larger than the measured value.

If the calculated optimum value of efficiency is only a little larger than the measured value, the precipitator is probably functioning well but nonideal conditions are having some effect on the performance. In this case, calculations should be made with the model in order to obtain NO-RAP + RAP overall mass collection efficiencies for various small values of σ_g and S and the rapping reentrainment parameters which are built into the computer program. If the measured efficiency can be predicted by the model with values of $\sigma_g \leq 0.25$ and $S \leq 0.1$, it is questionable whether or not improvements in the gas flow properties and mechanical design will result in an appreciable improvement in precipitator performance. A less costly and possibly more profitable exercise would be to vary the rapping intensities and frequencies in an attempt to minimize losses in collection efficiency due to rapping reentrainment. If $\sigma_g > 0.25$ or $S > 0.1$, these quantities should be measured. If the measured values of σ_g and S are consistent with those predicted by the model, the gas flow properties and mechanical design should be improved.

Step 4: Check to see if the calculated optimum efficiency is significantly larger than the measured value.

If the calculated optimum value of efficiency is significantly larger than the measured value, the precipitator is functioning poorly. Poor performance of a precipitator may be due to either one or a combination of several factors that can be analyzed with the model. These factors include the electrical operating conditions, nonuniform gas velocity distribution, gas bypassage of electrified regions, particle reentrainment without rapping, and rapping reentrainment. In the following steps, procedures are outlined that can be taken in an attempt to pinpoint the problem areas.

Step 5: Determine whether or not the operating currents are completely useful in the precipitation process.

At this point, the electrical operating conditions should be examined in order to determine whether or not the operating currents are completely useful in the precipitation process. If excessive sparking or back corona is occurring in the precipitator, the measured currents will not be totally useful in the precipitation process and, in fact, the nature of the currents may be very detrimental to precipitator performance. Use in the model of currents measured under these conditions will result in the prediction of much higher collection efficiencies than will be attained by the precipitator.

Step 5(a): Check for excessive sparking.

Sparking results in localized currents that are not very effective in charging particles. In addition, excessive sparking can lead to increased particle reentrainment by producing disruptions at the surface of the collected particulate layer and by producing reduced holding forces over large regions of the collected layer due to reduced currents to these regions.

If sparking is occurring, the extent of the sparking should be determined by using spark rate meters or other appropriate instrumentation. If excessive sparking is occurring, the applied voltage should be lowered until the spark rate is at a level which is not detrimental to the performance of the precipitator. Although the operating voltages and currents will be reduced, the performance of the precipitator will improve and the use of these operating electrical conditions in the model will give better agreement between predicted and measured collection efficiencies.

Step 5(b): Check for the existence of back corona.

If excessive sparking is not occurring, a check should be made to determine whether or not a condition of back corona exists in the precipitator. When back corona exists, both positive and negative ions move in the interelectrode space and this results in a reduction in the negative charge that can be acquired by a particle.

Two methods can be used to check for the existence of back corona. First, the measured value of ash resistivity and Figure 1 can be used to estimate the maximum allowable current density. If the current density in the precipitator greatly exceeds this value, the precipitator is probably operating in back corona. As a second method of checking for the existence of back corona, the voltage-current curves for the different electrical sections can be checked to see if at some point on the curve increased current is obtained at a reduced applied voltage. If this is the case and the precipitator is operating in this region of the voltage-current curve, then back corona is occurring in the precipitator.

If back corona is occurring, the applied voltage should be lowered in order to obtain a current density which will not lead to the formation of back corona. The reduced voltages and currents will result in improved performance of the precipitator and the use of these operating electrical conditions in the model will give better agreement between predicted and measured collection efficiencies.

Step 5(c): Consider electrode misalignment.

As a further consideration concerning the electrical conditions, the electrode alignment should be taken into account. Consideration of electrode alignment is especially important when troubleshooting hot precipitators. In hot precipitators, the collection plates may buckle if proper precautions have not been taken to allow for the expansion of the plates at the elevated temperatures. If buckling of the plates occurs, higher currents will be measured but they will be localized. Currents of this type are not desirable for treating particles. The existence of this type of misalignment should be evidenced by steep voltage-current curves with a narrow voltage range from corona initiation to sparkover. Use in the model of measured currents obtained from this type of situation will result in predicted collection efficiencies that are well above those which are attained.

Step 6: Estimate the effect that various nonideal conditions could have on the performance of the precipitator.

If the poor performance of the precipitator can not be traced to the electrical operating conditions, then the nonideal effects of nonuniform gas velocity distribution, gas bypassage of electrified regions, and particle reentrainment should be considered next. The effect of σ_g and S on the NO-RAP + RAP overall mass collection efficiency of the precipitator should be analyzed in a systematic fashion with the model.

Step 6(a): Estimate the possible effect of nonuniform velocity distribution on the performance of the precipitator.

In order to determine whether or not a nonuniform gas velocity distribution could be responsible for the poor performance of the precipitator, calculations should be made for S = 0 and values of σ_g ranging from 0 to at least 2.0. If a certain value of σ_g in the chosen range produces the necessary reduction in collection efficiency and this value is not completely out of line with available information concerning the gas flow, interfacing of the precipitator with the duct work, existence of gas diffusion plates, etc., then the actual value of σ_g should be determined experimentally by making a velocity traverse in a plane at the inlet of the precipitator. If the measured value of σ_g is greater than 0.25, measures should be taken to improve the gas flow distribution.

Step 6(b): Estimate the possible effect of gas sneakage and/or particle reentrainment without rapping on the performance of the precipitator.

In order to determine the extent of gas bypassage of the electrified regions and/or particle reentrainment without rapping that would be necessary to cause the poor performance of the precipitator, calculations should be made for $\sigma_g = 0$ and values of S ranging from 0 to 0.9. There will be a value of S in this range that will result in the necessary reduction in collection efficiency. Depending on the value of S, different interpretations can be made. If S is not too large ($S \leq 0.2$), then the poor performance might be attributed to either excessive gas bypassage of the electrified regions or excessive particle reentrainment without rapping or very poor gas velocity distribution or a combination of all three of these effects where neither effect alone is very detrimental to the performance of the precipitator. In this case, measurements should be made under air-load conditions to determine σ_g and the fraction of the gas volume flow passing through nonelectrified regions in each baffled section. If the measured values of these quantities are such that they can account for a major part of the reduction in collection efficiency, then the appropriate corrective measures can be made to the mechanical design of the precipitator. If the measured values of these quantities are such that they can not account for a major part of the reduction in collection efficiency, then it is possible that particle reentrainment without rapping is having an adverse effect on the performance of the precipitator. This could be due to factors which include a high average gas velocity, a very nonuniform gas velocity distribution, a low value of ash resistivity, excessive sparking, low operating current densities, and hopper problems. All of these factors can lead to particle reentrainment from causes other than rapping and should be taken into account in the troubleshooting analysis.

If S is large ($S > 0.2$), the poor performance of the precipitator is probably due primarily to extremely excessive particle reentrainment. This could be a result of one or more of the same factors mentioned above. In this case, reentrainment of particles from the hoppers, caused by poor gas flow qualities or by hopper malfunctions, should receive more serious attention as a possible cause of the poor performance. If very large values of S are needed to predict the reduction in collection efficiency, then it is also possible that rapping reentrainment is occurring to a much greater extent than that predicted by the rapping reentrainment calculation and that this is reflected in the value of S. If the value of S is large, then hopper operation should be checked, outlet mass loadings should be obtained with and without rapping, and real-time measurements of the outlet mass loading should be made. These measures should indicate whether the problem is due to hopper operation or rapping reentrainment or reentrainment without rapping or some combination of the three.

The troubleshooting procedure described above can be a valuable tool in helping to diagnose the causes of poor performance of a precipitator. Since the procedure involves only limited experimental data, it is not costly to perform. Use of the procedure can also result in time and cost savings by giving direction and helping to focus on those quantities which actually need to be measured. A further benefit of using the procedure is the possibility that costly modifications to the precipitator that will not result in significant improvement in the performance can be avoided.

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APPENDIX A

OUTPUT DATA FROM EXAMPLE 1

```
                   **************************************
                   *                                    *
                   *          E.P.A. ESP MODEL          *
                   *    I.E.R.L.-R.T.P. AND SO.R.I.     *
                   *            REVISION III            *
                   *                                    *
                   **************************************

PRINTOUT OF INPUT DATA FOR DATA SET NUMBER  1


>>>>> CHECK VALUE OF DL
>>>>> CHECK VALUE OF AS( 1)
>>>>> CHECK VALUE OF TEMPS( 1)
>>>>> CHECK VALUE OF AS( 2)
>>>>> CHECK VALUE OF TEMPS( 2)
>>>>> CHECK VALUE OF TEMPS( 3)

 DATA ON CARD NUMBER   1

 NENDPT = 16   NDATA =  1   NRAP =  0   NODL =  0   NOPRNT =  0   PATHL =  0.00 FT   NCOMPS =  0   NWAVES =  0  NLAMDA =  0

 DATA ON CARD NUMBER   2

 LAB ESP: SCA=125FT2/1000ACFM;J=24.0UA/FT2

 DATA ON CARD NUMBER   3

 NEST =  1  NDIST =  1  NVI =  1  NX = 10  NY = 10  NITER =  3  NCALC =  0  NRAPD =  1  NEFF =  1  NTEMP =  1  NONID =  2

 DATA ON CARD NUMBER   4

 NN =  5

 DATA ON CARD NUMBER   5

 DL =  0.01500 GRN/ACF  PL =  10.0000 FT  ETAO = 99.00000 %  DD =  1000.00 KG/M**3  EPS =  5.100E+00
 VRATIO =   1.0300  US =  .000165 M**2/V-SEC  FPATH =   1.0000  EBD = 1500000. V/M  RHOCOS =  1.00E+09 OHM-CM
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```
DATA ON CARD NUMBER   6

ASHUCK( 1) =  .00  AZIGGY( 1) =  .00  AZNUMS( 1) =  4.0
ASHUCK( 2) =  .10  AZIGGY( 2) =  .10  AZNUMS( 2) =  4.0


DATA ON CARD NUMBER   7

ENDPT( 1) =    0.200 UM   ENDPT( 2) =    0.300 UM   ENDPT( 3) =    0.400 UM   ENDPT( 4) =    0.500 UM   ENDPT( 5) =    0.600 UM
ENDPT( 6) =    0.800 UM   ENDPT( 7) =    1.000 UM   ENDPT( 8) =    1.200 UM   ENDPT( 9) =    1.400 UM   ENDPT(10) =    1.800 UM


DATA ON CARD NUMBER   8

ENDPT(11) =    2.200 UM   ENDPT(12) =    3.000 UM   ENDPT(13) =    4.000 UM   ENDPT(14) =    6.000 UM   ENDPT(15) =   10.000 UM
ENDPT(16) =   20.000 UM

DATA ON CARD NUMBER   9

PRCU( 1) =   0.0000 %   PRCU( 2) =   0.0002 %   PRCU( 3) =   0.4002 %   PRCU( 4) =   1.0002 %   PRCU( 5) =   2.6672 %
PRCU( 6) =   7.6672 %   PRCU( 7) =  12.6002 %   PRCU( 8) =  17.6002 %   PRCU( 9) =  21.3332 %   PRCU(10) =  29.3332 %


DATA ON CARD NUMBER  10

PRCU(11) =  36.0002 %   PRCU(12) =  46.6672 %   PRCU(13) =  57.3342 %   PRCU(14) =  68.6672 %   PRCU(15) =  80.6672 %
PRCU(16) = 100.0000 %

DATA ON CARD NUMBER  11

NUMSEC =  3    LSECT( 1) =  3  LSECT( 2) =  3  LSECT( 3) =  6

DATA ON CARD NUMBER  12

AS( 1) =  6.2500E+00 FT**2  VOS( 1) =  4.6000E+04 V  TCS( 1) =  1.5000E-04 A  WLS( 1) =  6.2500E+00 FT
ACS( 1) =  4.6875E-02 IN  BS( 1) =  5.0000E+00 IN  NWS( 1) =  5.0000E+00

DATA ON CARD NUMBER  13

SYS( 1) =  2.5000E+00 IN  VGS( 1) =  2.0000E+02 FT**3/MIN  VGASS( 1) =  3.2000E+00 FT/SEC  TEMPS( 1) =  7.6800E+01 F
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PS( 1) =  1.0000E+00 ATM  VISS( 1) =  1.8000E-05 KG/M-SEC  LINCS( 1) =  8.3333E-01 FT

DATA ON CARD NUMBER  14

AS( 2) =  6.2500E+00 FT**2  VOS( 2) =  4.5800E+04 V  TCS( 2) =  1.5000E-04 A  WLS( 2) =  6.2500E+00 FT
ACS( 2) =  4.6875E-02 IN  BS( 2) =  5.0000E+00 IN  NWS( 2) =  5.0000E+00

DATA ON CARD NUMBER  15

SYS( 2) =  2.5000E+00 IN  VGS( 2) =  2.0000E+02 FT**3/MIN  VGASS( 2) =  3.2000E+00 FT/SEC  TEMPS( 2) =  7.6800E+01 F
PS( 2) =  1.0000E+00 ATM  VISS( 2) =  1.8000E-05 KG/M-SEC  LINCS( 2) =  8.3333E-01 FT

DATA ON CARD NUMBER  16

AS( 3) =  1.2500E+01 FT**2  VOS( 3) =  4.4400E+04 V  TCS( 3) =  3.0000E-04 A  WLS( 3) =  1.2500E+01 FT
ACS( 3) =  4.6875E-02 IN  BS( 3) =  5.0000E+00 IN  NWS( 3) =  1.0000E+01

DATA ON CARD NUMBER  17

SYS( 3) =  2.5000E+00 IN  VGS( 3) =  2.0000E+02 FT**3/MIN  VGASS( 3) =  3.2000E+00 FT/SEC  TEMPS( 3) =  7.6800E+01 F
PS( 3) =  1.0000E+00 ATM  VISS( 3) =  1.8000E-05 KG/M-SEC  LINCS( 3) =  8.3333E-01 FT
```

```
INCREMENTAL ANALYSIS OF PRECIPITATOR PERFORMANCE


LAB ESP: SCA=125FT2/1000ACFM;J=24.0UA/FT2


CALCULATION IS IN SECTION NO. = 1

SECTION LENGTH      0.7625 M                GAS TEMPERATURE    297.67 K                   APPLIED VOLTAGE    4.600E+04 V
LENGTH INCREMENT    0.2542 M                GAS PRESSURE       1.00 ATM                   TOTAL CURRENT      1.500E-04 A
COLLECTION AREA     5.8125E-01 M2           GAS VISCOSITY      1.800E-05 KG/M*S           CURRENT DENSITY    2.581E-04 A/M2
WIRE-TO-WIRE        0.1270 M                GAS VOLUME FLOW    9.460E-02 M3/S             WIRE CURRENT/M     7.869E-05 A/M
WIRE-TO-PLATE       0.1270 M                GAS LINEAR FLOW    9.760E-01 M/S              DUST LAYER FIELD   2.581E+03 V/M
INCOMING DUST       3.4350E-05 KG/M3        ION MOBILITY       1.798E-04 M2/V*S           EST. INCR. PEN.    68.13 %

INCREMENT   ROVRI     E AVERAGE    E PLATE    REDUCED FID   J TOTAL   DUST MMD   DUST KG/M3   DUST LAYER    J DUST      J IONS
 NUMBER                 V/M          V/M       IONS/M3      NA/CM2    REMOVED     REMOVED     MM/MINUTE     A/M2        A/M2

    1       1.043    3.622E+05  2.7322E+05  2.3744E+13     25.8     6.83E-06   1.041E-05    3.049E-04   5.01E-08    2.58E-04
    2       1.050    3.622E+05  2.7322E+05  2.3582E+13     25.8     4.04E-06   6.457E-06    1.892E-04   5.97E-08    2.58E-04
    3       1.039    3.622E+05  2.7323E+05  2.3833E+13     25.8     2.88E-06   4.097E-06    1.200E-04   5.31E-08    2.58E-04


CALCULATION IS IN SECTION NO. = 2

SECTION LENGTH      0.7625 M                GAS TEMPERATURE    297.67 K                   APPLIED VOLTAGE    4.580E+04 V
LENGTH INCREMENT    0.2542 M                GAS PRESSURE       1.00 ATM                   TOTAL CURRENT      1.500E-04 A
COLLECTION AREA     5.8125E-01 M2           GAS VISCOSITY      1.800E-05 KG/M*S           CURRENT DENSITY    2.581E-04 A/M2
WIRE-TO-WIRE        0.1270 M                GAS VOLUME FLOW    9.460E-02 M3/S             WIRE CURRENT/M     7.869E-05 A/M
WIRE-TO-PLATE       0.1270 M                GAS LINEAR FLOW    9.760E-01 M/S              DUST LAYER FIELD   2.581E+03 V/M
INCOMING DUST       1.3388E-05 KG/M3        ION MOBILITY       1.798E-04 M2/V*S           EST. INCR. PEN.    68.13 %

INCREMENT   ROVRI     E AVERAGE    E PLATE    REDUCED FID   J TOTAL   DUST MMD   DUST KG/M3   DUST LAYER    J DUST      J IONS
 NUMBER                 V/M          V/M       IONS/M3      NA/CM2    REMOVED     REMOVED     MM/MINUTE     A/M2        A/M2

    4       1.024    3.606E+05  2.7135E+05  2.4281E+13     25.8     2.35E-06   2.823E-06    8.271E-05   4.59E-08    2.58E-04
    5       1.015    3.606E+05  2.7135E+05  2.4510E+13     25.8     2.04E-06   2.081E-06    6.095E-05   3.99E-08    2.58E-04
    6       1.009    3.606E+05  2.7135E+05  2.4654E+13     25.8     1.80E-06   1.589E-06    4.654E-05   3.46E-08    2.58E-04


CALCULATION IS IN SECTION NO. = 3

SECTION LENGTH      1.5250 M                GAS TEMPERATURE    297.67 K                   APPLIED VOLTAGE    4.440E+04 V
LENGTH INCREMENT    0.2542 M                GAS PRESSURE       1.00 ATM                   TOTAL CURRENT      3.000E-04 A
COLLECTION AREA     1.1625E+00 M2           GAS VISCOSITY      1.800E-05 KG/M*S           CURRENT DENSITY    2.581E-04 A/M2
WIRE-TO-WIRE        0.1270 M                GAS VOLUME FLOW    9.460E-02 M3/S             WIRE CURRENT/M     7.869E-05 A/M
WIRE-TO-PLATE       0.1270 M                GAS LINEAR FLOW    9.760E-01 M/S              DUST LAYER FIELD   2.581E+03 V/M
INCOMING DUST       6.8952E-06 KG/M3        ION MOBILITY       1.798E-04 M2/V*S           EST. INCR. PEN.    68.13 %

INCREMENT   ROVRI     E AVERAGE    E PLATE    REDUCED FID   J TOTAL   DUST MMD   DUST KG/M3   DUST LAYER    J DUST      J IONS
 NUMBER                 V/M          V/M       IONS/M3      NA/CM2    REMOVED     REMOVED     MM/MINUTE     A/M2        A/M2
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```
   7      1.005    3.496E+05  2.6464E+05  2.5522E+13    25.8     1.60E-06    1.211E-06   3.547E-05   2.92E-08    2.58E-04
   8      1.003    3.496E+05  2.6464E+05  2.5576E+13    25.8     1.50E-06    9.653E-07   2.828E-05   2.53E-08    2.58E-04
   9      1.002    3.496E+05  2.6464E+05  2.5609E+13    25.8     1.42E-06    7.789E-07   2.282E-05   2.20E-08    2.58E-04
  10      1.001    3.496E+05  2.6464E+05  2.5629E+13    25.8     1.35E-06    6.348E-07   1.860E-05   1.92E-08    2.58E-04
  11      1.001    3.496E+05  2.6464E+05  2.5641E+13    25.8     1.28E-06    5.212E-07   1.527E-05   1.68E-08    2.58E-04
  12      1.000    3.496E+05  2.6464E+05  2.5648E+13    25.8     1.20E-06    4.309E-07   1.262E-05   1.46E-08    2.58E-04

EST. EFFICIENCY = 99.00     UNCORRECTED COMPUTED EFFICIENCY = 93.15

INCREMENTAL ANALYSIS OF PRECIPITATOR PERFORMANCE


LAB ESP: SCA=125FT2/1000ACFM;J=24.0UA/FT2



CALCULATION IS IN SECTION NO. = 1

SECTION LENGTH      0.7625 M                GAS TEMPERATURE     297.67 K                APPLIED VOLTAGE     4.600E+04 V
LENGTH INCREMENT    0.2542 M                GAS PRESSURE        1.00 ATM                TOTAL CURRENT       1.500E-04 A
COLLECTION AREA     5.8125E-01 M2           GAS VISCOSITY       1.800E-05 KG/M*S        CURRENT DENSITY     2.581E-04 A/M2
WIRE-TO-WIRE        0.1270 M                GAS VOLUME FLOW     9.460E-02 M3/S          WIRE CURRENT/M      7.869E-05 A/M
WIRE-TO-PLATE       0.1270 M                GAS LINEAR FLOW     9.760E-01 M/S           DUST LAYER FIELD    2.581E+03 V/M
INCOMING DUST       3.4350E-05 KG/M3        ION MOBILITY        1.798E-04 M2/V*S        EST. INCR. PEN.     79.98 %

INCREMENT   ROVRI     E AVERAGE   E PLATE    REDUCED FID   J TOTAL   DUST MMD    DUST KG/M3   DUST LAYER   J DUST      J IONS
  NUMBER                 V/M        V/M       IONS/M3      NA/CM2    REMOVED     REMOVED      MM/MINUTE    A/M2        A/M2

   1        1.027    3.622E+05  2.7230E+05  2.4114E+13    25.8     6.83E-06    1.038E-05   3.042E-04   5.00E-08    2.58E-04
   2        1.037    3.622E+05  2.7323E+05  2.3882E+13    25.8     4.04E-06    6.472E-06   1.896E-04   5.99E-08    2.58E-04
   3        1.034    3.622E+05  2.7323E+05  2.3953E+13    25.8     2.88E-06    4.103E-06   1.202E-04   5.32E-08    2.58E-04


CALCULATION IS IN SECTION NO. = 2

SECTION LENGTH      0.7625 M                GAS TEMPERATURE     297.67 K                APPLIED VOLTAGE     4.580E+04 V
LENGTH INCREMENT    0.2542 M                GAS PRESSURE        1.00 ATM                TOTAL CURRENT       1.500E-04 A
COLLECTION AREA     5.8125E-01 M2           GAS VISCOSITY       1.800E-05 KG/M*S        CURRENT DENSITY     2.581E-04 A/M2
WIRE-TO-WIRE        0.1270 M                GAS VOLUME FLOW     9.460E-02 M3/S          WIRE CURRENT/M      7.869E-05 A/M
WIRE-TO-PLATE       0.1270 M                GAS LINEAR FLOW     9.760E-01 M/S           DUST LAYER FIELD    2.581E+03 V/M
INCOMING DUST       1.3392E-05 KG/M3        ION MOBILITY        1.798E-04 M2/V*S        EST. INCR. PEN.     79.98 %

INCREMENT   ROVRI     E AVERAGE   E PLATE    REDUCED FID   J TOTAL   DUST MMD    DUST KG/M3   DUST LAYER   J DUST      J IONS
  NUMBER                 V/M        V/M       IONS/M3      NA/CM2    REMOVED     REMOVED      MM/MINUTE    A/M2        A/M2

   4        1.025    3.606E+05  2.7134E+05  2.4271E+13    25.8     2.35E-06    2.826E-06   8.279E-05   4.60E-08    2.58E-04
   5        1.018    3.606E+05  2.7134E+05  2.4441E+13    25.8     2.04E-06    2.082E-06   6.098E-05   3.99E-08    2.58E-04
   6        1.013    3.606E+05  2.7134E+05  2.4566E+13    25.8     1.80E-06    1.589E-06   4.656E-05   3.46E-08    2.58E-04


CALCULATION IS IN SECTION NO. = 3

SECTION LENGTH      1.5250 M                GAS TEMPERATURE     297.67 K                APPLIED VOLTAGE     4.440E+04 V
LENGTH INCREMENT    0.2542 M                GAS PRESSURE        1.00 ATM                TOTAL CURRENT       3.000E-04 A
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COLLECTION AREA    1.1625E+00 M2          GAS VISCOSITY      1.800E-05 KG/M*S         CURRENT DENSITY    2.581E-04 A/M2
WIRE-TO-WIRE       0.1270 M               GAS VOLUME FLOW    9.460E-02 M3/S           WIRE CURRENT/M     7.869E-05 A/M
WIRE-TO-PLATE      0.1270 M               GAS LINEAR FLOW    9.760E-01 M/S            DUST LAYER FIELD   2.581E+03 V/M
INCOMING DUST      6.8955E-06 KG/M3       ION MOBILITY       1.798E-04 M2/V*S         EST. INCR. PEN.    79.98 %

INCREMENT   ROVRI      E AVERAGE   E PLATE     REDUCED FID   J TOTAL    DUST MMD    DUST KG/M3   DUST LAYER   J DUST       J IONS
 NUMBER                  V/M         V/M        IONS/M3      NA/CM2     REMOVED     REMOVED      MM/MINUTE    A/M2         A/M2

     7       1.009     3.496E+05  2.6465E+05  2.5434E+13     25.8       1.60E-06    1.211E-06    3.548E-05   2.92E-08     2.58E-04
     8       1.006     3.496E+05  2.6465E+05  2.5500E+13     25.8       1.50E-06    9.654E-07    2.828E-05   2.53E-08     2.58E-04
     9       1.004     3.496E+05  2.6465E+05  2.5547E+13     25.8       1.42E-06    7.790E-07    2.282E-05   2.20E-08     2.58E-04
    10       1.003     3.496E+05  2.6465E+05  2.5580E+13     25.8       1.35E-06    6.348E-07    1.860E-05   1.92E-08     2.58E-04
    11       1.002     3.496E+05  2.6465E+05  2.5603E+13     25.8       1.28E-06    5.212E-07    1.527E-05   1.67E-08     2.58E-04
    12       1.002     3.496E+05  2.6465E+05  2.5620E+13     25.8       1.20E-06    4.309E-07    1.262E-05   1.46E-08     2.58E-04

EST EFFICIENCY = 93.15     COMPUTED EFFICIENCY = 93.15     CONVERGES
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CHARGING RATES FOR PARTICLE SIZES FROM SUBROUTINE CHARGN OR CHGSUM

INCREMENT NO.     Q/QSATF FOR INDICATED PARTICLE SIZES

         0.2500E-06  0.3500E-06  0.4500E-06  0.5500E-06  0.7000E-06  0.9000E-06  0.1100E-05  0.1300E-05

    1      1.0360      1.0360      1.0360      1.0360      1.0360      1.0360      1.0360      1.0360
    2      1.6775      1.6489      1.6047      1.5612      1.5043      1.4446      1.3993      1.3642
    3      1.8857      1.8314      1.7653      1.7046      1.6287      1.5514      1.4941      1.4503
    4      2.0107      1.9390      1.8592      1.7879      1.7003      1.6126      1.5480      1.4991
    5      2.1002      2.0157      1.9258      1.8469      1.7510      1.6558      1.5862      1.5336
    6      2.1698      2.0750      1.9773      1.8925      1.7902      1.6893      1.6157      1.5602
    7      2.2234      2.1195      2.0150      1.9252      1.8175      1.7117      1.6349      1.5770
    8      2.2689      2.1574      2.0472      1.9531      1.8409      1.7311      1.6516      1.5916
    9      2.3085      2.1904      2.0753      1.9776      1.8614      1.7482      1.6662      1.6045
   10      2.3434      2.2195      2.1001      1.9992      1.8797      1.7633      1.6793      1.6160
   11      2.3747      2.2456      2.1224      2.0187      1.8961      1.7770      1.6911      1.6264
   12      2.4030      2.2693      2.1426      2.0363      1.9110      1.7894      1.7018      1.6359

         0.1600E-05  0.2000E-05  0.2600E-05  0.3500E-05  0.5000E-05  0.8000E-05  0.1500E-04

    1      1.0360      1.0360      1.0360      1.0360      1.0360      1.0360      1.0360
    2      1.3250      1.2888      1.2540      1.2226      1.1917      1.1569      1.1178
    3      1.4017      1.3567      1.3126      1.2714      1.2301      1.1842      1.1351
    4      1.4447      1.3944      1.3445      1.2975      1.2501      1.1980      1.1434
    5      1.4752      1.4210      1.3670      1.3158      1.2641      1.2078      1.1493
    6      1.4987      1.4414      1.3843      1.3299      1.2749      1.2154      1.1540
    7      1.5128      1.4531      1.3935      1.3366      1.2793      1.2176      1.1540
    8      1.5252      1.4634      1.4016      1.3426      1.2793      1.2176      1.1540
    9      1.5362      1.4725      1.4088      1.3426      1.2793      1.2176      1.1540
   10      1.5460      1.4808      1.4153      1.3426      1.2793      1.2176      1.1540
   11      1.5549      1.4882      1.4153      1.3426      1.2793      1.2176      1.1540
   12      1.5631      1.4951      1.4153      1.3426      1.2793      1.2176      1.1540
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CHARGE ACCUMULATED ON PARTICLE SIZES IN EACH INCREMENT

INCREMENT         CHARGE FOR INDICATED PARTICLE SIZES

        0.2500E-06    0.3500E-06    0.4500E-06    0.5500E-06    0.7000E-06    0.9000E-06    0.1100E-05    0.1300E-05

  1    0.18895E-17   0.33413E-17   0.52363E-17   0.75764E-17   0.11922E-16   0.19280E-16   0.28423E-16   0.39355E-16
  2    0.30595E-17   0.53178E-17   0.81104E-17   0.11416E-16   0.17311E-16   0.26883E-16   0.38388E-16   0.51820E-16
  3    0.34392E-17   0.59063E-17   0.89224E-17   0.12466E-16   0.18742E-16   0.28871E-16   0.40989E-16   0.55091E-16
  4    0.36671E-17   0.62535E-17   0.93965E-17   0.13074E-16   0.19566E-16   0.30008E-16   0.42470E-16   0.56943E-16
  5    0.38304E-17   0.65006E-17   0.97332E-17   0.13506E-16   0.20150E-16   0.30814E-16   0.43518E-16   0.58254E-16
  6    0.39573E-17   0.66921E-17   0.99935E-17   0.13839E-16   0.20601E-16   0.31435E-16   0.44327E-16   0.59265E-16
  7    0.40550E-17   0.68355E-17   0.10184E-16   0.14078E-16   0.20915E-16   0.31854E-16   0.44854E-16   0.59903E-16
  8    0.41381E-17   0.69577E-17   0.10347E-16   0.14283E-16   0.21185E-16   0.32215E-16   0.45310E-16   0.60458E-16
  9    0.42102E-17   0.70640E-17   0.10489E-16   0.14462E-16   0.21421E-16   0.32532E-16   0.45712E-16   0.60947E-16
 10    0.42740E-17   0.71581E-17   0.10614E-16   0.14620E-16   0.21631E-16   0.32814E-16   0.46070E-16   0.61385E-16
 11    0.43310E-17   0.72423E-17   0.10727E-16   0.14762E-16   0.21819E-16   0.33068E-16   0.46394E-16   0.61781E-16
 12    0.43827E-17   0.73185E-17   0.10829E-16   0.14891E-16   0.21991E-16   0.33299E-16   0.46688E-16   0.62142E-16


        0.1600E-05    0.2000E-05    0.2600E-05    0.3500E-05    0.5000E-05    0.8000E-05    0.1500E-04

  1    0.59103E-16   0.91693E-16   0.15399E-15   0.27760E-15   0.56409E-15   0.14388E-14   0.50445E-14
  2    0.75588E-16   0.11406E-15   0.18638E-15   0.32758E-15   0.64887E-15   0.16067E-14   0.54427E-14
  3    0.79962E-16   0.12007E-15   0.19509E-15   0.34067E-15   0.66975E-15   0.16447E-14   0.55270E-14
  4    0.82419E-16   0.12341E-15   0.19984E-15   0.34766E-15   0.68063E-15   0.16638E-14   0.55671E-14
  5    0.84157E-16   0.12576E-15   0.20319E-15   0.35258E-15   0.68829E-15   0.16774E-14   0.55961E-14
  6    0.85495E-16   0.12757E-15   0.20575E-15   0.35634E-15   0.69417E-15   0.16879E-14   0.56187E-14
  7    0.86304E-16   0.12861E-15   0.20711E-15   0.35813E-15   0.69654E-15   0.16910E-14   0.56187E-14
  8    0.87010E-16   0.12952E-15   0.20832E-15   0.35974E-15   0.69654E-15   0.16910E-14   0.56187E-14
  9    0.87636E-16   0.13032E-15   0.20939E-15   0.35974E-15   0.69654E-15   0.16910E-14   0.56187E-14
 10    0.88196E-16   0.13105E-15   0.21036E-15   0.35974E-15   0.69654E-15   0.16910E-14   0.56187E-14
 11    0.88705E-16   0.13171E-15   0.21036E-15   0.35974E-15   0.69654E-15   0.16910E-14   0.56187E-14
 12    0.89168E-16   0.13232E-15   0.21036E-15   0.35974E-15   0.69654E-15   0.16910E-14   0.56187E-14
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PARTICLE SIZE RANGE STATISTICS

CORRECTIONS FOR NON-IDEAL CONDITIONS USING SET NO.  1 OF CORRECTION PARAMETERS

 PARTICLE     CCF    INLET %    OUTLET %      CORRECTED      NO-RAP      NO-RAP       NO-RAP   CORRECTED   CORRECTED    CORRECTED
 DIAMETER            IN BAND    IN BAND       OUTLET %     EFFICIENCY  MIG. VEL.      PEN.    EFFICIENCY   MIG. VEL.   PENETRATION

2.500E-07   1.590     0.000     0.0009        0.0005       88.5125       8.805     11.4875     88.5125       8.805       11.4875
3.500E-07   1.414     0.400     1.8644        1.1277       88.6127       8.840     11.3873     88.1640       8.683       11.8360
4.500E-07   1.320     0.600     2.6421        1.6121       89.2420       9.071     10.7580     88.7200       8.879       11.2800
5.500E-07   1.261     1.667     6.7192        4.0206       90.1525       9.431      9.8475     89.8743       9.318       10.1257
7.000E-07   1.205     5.000    17.7460       10.6595       91.3289       9.949      8.6711     91.0496       9.820        8.9504
9.000E-07   1.159     4.933    14.4955        8.9090       92.8210      10.717      7.1790     92.4178      10.495        7.5822
1.100E-06   1.130     5.000    12.2850        7.7445       93.9973      11.445      6.0027     93.4972      11.120        6.5028
1.300E-06   1.110     3.733     7.6744        5.1607       94.9774      12.171      5.0226     94.1960      11.582        5.8040
1.600E-06   1.090     8.000    12.9599        9.1441       96.0422      13.140      3.9578     95.2013      12.356        4.7987
2.000E-06   1.072     6.667     7.9791        6.4140       97.0761      14.372      2.9239     95.9610      13.058        4.0390
2.600E-06   1.055    10.667     8.4167        8.5750       98.0723      16.067      1.9277     96.6251      13.788        3.3749
3.500E-06   1.041    10.667     5.0138        7.2832       98.8517      18.175      1.1483     97.1335      14.453        2.8665
5.000E-06   1.029    11.333     2.0657        8.3514       99.5547      22.029      0.4453     96.9062      14.142        3.0938
8.000E-06   1.018    12.000     0.1366        8.9213       99.9722      33.314      0.0278     96.8788      14.106        3.1212
1.500E-05   1.010    19.333     0.0008       12.0762       99.9999      58.994      0.0001     97.3775      14.815        2.6225

EFFICIENCIES FOR CONVERGENCE CHECK:  STATED OR PREVIOUS CALCULATION =  93.149   FINAL CALCULATION =  93.150


    MMD OF INLET SIZE DISTRIBUTION    =  3.30
    SIGMAP OF INLET SIZE DISTRIBUTION =  2.16
    QUALITY OF LOG-NORMAL FIT =  .934
    GAS VELOCITY SIGMAG = 0.00
    SNEAKAGE FRACTION   = 0.00
    NO. BAFFLED STAGES  = 4.
    NTEMP = 1
    RAPPING MMD   =  6.00
    RAPPING SIGMA =  2.50

    ADJUSTED NO-RAP EFF. =  97.5569
    MMD OF EFFLUENT UNDER NO-RAP CONDITIONS    = 1.27
    SIGMAP OF EFFLUENT UNDER NO-RAP CONDITIONS = 1.62
    QUALITY OF LOG-NORMAL FIT =  .962
    PRECIPITATION RATE PARAMETER UNDER NO-RAP CONDITIONS = 15.103

    EFF. CORRECTED FOR RAPPING =  95.8017
    CORRECTED MMD OF EFFLUENT    = 2.39
    CORRECTED SIGMAP OF EFFLUENT = 2.17
    QUALITY OF LOG-NORMAL FIT =  .913
    CORRECTED PRECIPITATION RATE PARAMETER =   12.90
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UNADJUSTED MIGRATION VELOCITIES AND EFFICIENCIES, AND DISCRETE OUTLET MASS LOADINGS

 PARTICLE   IDEAL UNADJUSTED   IDEAL UNADJUSTED    NO-RAP     RAPPING PUFF   NO-RAP+RAP PUFF   RAPPING PUFF
   DIAM.       MIG. VEL.          EFFICIENCY      DM/DLOGD      DM/DLOGD        DM/DLOGD       DISTRIBUTION
    (M)        (CM/SEC)              (%)          (MG/DSCM)    (MG/DSCM)       (MG/DSCM)           (%)

 2.500E-07     3.787E+00          6.057E+01       4.896E-05     1.632E-03       1.680E-03        4.360E-02
 3.500E-07     4.074E+00          6.326E+01       1.368E-01     5.391E-03       1.422E-01        1.022E-01
 4.500E-07     4.425E+00          6.630E+01       2.499E-01     1.213E-02       2.621E-01        1.784E-01
 5.500E-07     4.800E+00          6.926E+01       7.780E-01     2.198E-02       8.000E-01        2.642E-01
 7.000E-07     5.378E+00          7.333E+01       1.302E+00     4.194E-02       1.344E+00        7.953E-01
 9.000E-07     6.159E+00          7.799E+01       1.371E+00     7.700E-02       1.448E+00        1.132E+00
 1.100E-06     6.945E+00          8.186E+01       1.422E+00     1.185E-01       1.541E+00        1.424E+00
 1.300E-06     7.732E+00          8.505E+01       1.051E+00     1.635E-01       1.214E+00        1.661E+00
 1.600E-06     8.915E+00          8.882E+01       1.089E+00     2.313E-01       1.320E+00        3.831E+00
 2.000E-06     1.049E+01          9.241E+01       8.394E-01     3.201E-01       1.159E+00        4.234E+00
 2.600E-06     1.283E+01          9.573E+01       5.729E-01     4.301E-01       1.003E+00        8.791E+00
 3.500E-06     1.630E+01          9.818E+01       3.679E-01     5.505E-01       9.184E-01        1.044E+01
 5.000E-06     2.203E+01          9.955E+01       1.075E-01     6.396E-01       7.472E-01        1.709E+01
 8.000E-06     3.331E+01          9.997E+01       5.644E-03     6.279E-01       6.335E-01        2.114E+01
 1.500E-05     5.899E+01          1.000E+02       2.413E-05     6.320F-01       6.320E-01        2.887E+01
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                                   E.P.A. ESP MODEL
                                I.E.R.L.-R.T.P. AND SO.R.I.

                               SUMMARY TABLE OF ESP OPERATING
                                 PARAMETERS AND PERFORMANCE


                                    DATA SET NUMBER   1

                              NON-IDEAL CONDITION SET NUMBER  1

          ESP PERFORMANCE:         PENETRATION =   4.2 %

                                   EFFICIENCY  =  95.8 %

                                   SCA         =  24.6 M2/(M3/SEC)  = 125. FT2/(1000 ACFM)


          ELECTRICAL CONDITIONS:   AVG. APPLIED VOLTAGE =  45.1 KV

                                   AVG. CURRENT DENSITY =  25.8 NA/CM2

                                   FLY ASH RESISTIVITY  =   1.0E+09 OHM-CM


          SIZE DISTRIBUTIONS:      INLET MMD  =  3.3 UM    INLET SIGMAP  =  2.2

                                   OUTLET MMD =  2.4 UM    OUTLET SIGMAP =  2.2


          NON-IDEAL CONDITIONS:    GAS SNEAKAGE FRACTION = 0.00    RAPPING MMD    =  6.0 UM

                                   GAS VELOCITY SIGMAG   = 0.00    RAPPING SIGMAP =  2.5
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PARTICLE SIZE RANGE STATISTICS

CORRECTIONS FOR NON-IDEAL CONDITIONS USING SET NO.  2 OF CORRECTION PARAMETERS

                                                                                        NO-RAP   CORRECTED   CORRECTED    CORRECTED
 PARTICLE    CCF    INLET %    OUTLET %    CORRECTED    NO-RAP       NO-RAP        PEN.    EFFICIENCY   MIG. VEL.   PENETRATION
 DIAMETER           IN BAND    IN BAND     OUTLET %    EFFICIENCY   MIG. VEL.
                                                                                  15.0214    84.9786       7.713       15.0214
2.500E-07   1.590    0.000      0.0008      0.0005      84.9786        7.713      14.9597    84.5061       7.587       15.4939
3.500E-07   1.414    0.400      1.4987      1.0190      85.0403        7.730      14.2974    85.0812       7.741       14.9188
4.500E-07   1.320    0.600      2.1485      1.4717      85.7026        7.914      13.3002    86.3686       8.108       13.6314
5.500E-07   1.261    1.667      5.5529      3.7360      86.6998        8.208      11.9997    87.6678       8.516       12.3322
7.000E-07   1.205    5.000     15.0268     10.1378      88.0003        8.627      10.3026    89.2175       9.062       10.7825
9.000E-07   1.159    4.933     12.7287      8.7451      89.6974        9.248       8.9348    90.4699       9.565        9.5301
1.100E-06   1.130    5.000     11.1888      7.8343      91.0652        9.827       7.7646    91.3051       9.938        8.6949
1.300E-06   1.110    3.733      7.2595      5.3365      92.2354       10.398       6.4660    92.5330      10.557        7.4670
1.600E-06   1.090    8.000     12.9554      9.8214      93.5340       11.143       5.1544    93.5181      11.133        6.4819
2.000E-06   1.072    6.667      8.6067      7.1050      94.8456       12.065       3.8223    94.4549      11.768        5.5451
2.600E-06   1.055   10.667     10.2116      9.7250      96.1777       13.282       2.7197    95.2349      12.385        4.7651
3.500E-06   1.041   10.667      7.2658      8.3569      97.2803       14.667       1.5276    95.3194      12.458        4.6806
5.000E-06   1.029   11.333      4.3360      8.7213      98.4724       17.014       0.3340    95.9835      13.080        4.0165
8.000E-06   1.018   12.000      1.0037      7.9244      99.6660       23.200       0.0447    96.8334      14.048        3.1666
1.500E-05   1.010   19.333      0.2163     10.0652      99.9553       31.384

EFFICIENCIES FOR CONVERGENCE CHECK:  STATED OR PREVIOUS CALCULATION =  93.149   FINAL CALCULATION =  93.150

    MMD OF INLET SIZE DISTRIBUTION     =  3.30
    SIGMAP OF INLET SIZE DISTRIBUTION =  2.16
    QUALITY OF LOG-NORMAL FIT =  .934
    GAS VELOCITY SIGMAG = 0.10
    SNEAKAGE FRACTION    = 0.10
    NO. BAFFLED STAGES   = 4.
    NTEMP = 1
    RAPPING MMD    =  6.00
    RAPPING SIGMA =  2.50

    ADJUSTED NO-RAP EFF. =  96.0072
    MMD OF EFFLUENT UNDER NO-RAP CONDITIONS     = 1.47
    SIGMAP OF EFFLUENT UNDER NO-RAP CONDITIONS = 1.71
    QUALITY OF LOG-NORMAL FIT =  .961
    PRECIPITATION RATE PARAMETER UNDER NO-RAP CONDITIONS = 13.104

    EFF. CORRECTED FOR RAPPING =  93.9177
    CORRECTED MMD OF EFFLUENT    = 2.34
    CORRECTED SIGMAP OF EFFLUENT = 2.11
    QUALITY OF LOG-NORMAL FIT =  .923
    CORRECTED PRECIPITATION RATE PARAMETER =   11.39
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UNADJUSTED MIGRATION VELOCITIES AND EFFICIENCIES, AND DISCRETE OUTLET MASS LOADINGS

 PARTICLE   IDEAL UNADJUSTED  IDEAL UNADJUSTED    NO-RAP     RAPPING PUFF  NO-RAP+RAP PUFF  RAPPING PUFF
   DIAM.       MIG. VEL.         EFFICIENCY      DM/DLOGD      DM/DLOGD       DM/DLOGD      DISTRIBUTION
    (M)        (CM/SEC)             (%)         (MG/DSCM)     (MG/DSCM)      (MG/DSCM)          (%)

 2.500E-07     3.787E+00         6.057E+01      6.402E-05     1.942E-03      2.006E-03       4.360E-02
 3.500E-07     4.074E+00         6.326E+01      1.797E-01     6.418E-03      1.861E-01       1.022E-01
 4.500E-07     4.425E+00         6.630E+01      3.322E-01     1.444E-02      3.466E-01       1.784E-01
 5.500E-07     4.800E+00         6.926E+01      1.051E+00     2.617E-02      1.077E+00       2.642E-01
 7.000E-07     5.378E+00         7.333E+01      1.802E+00     4.993E-02      1.852E+00       7.953E-01
 9.000E-07     6.159E+00         7.799E+01      1.968E+00     9.167E-02      2.060E+00       1.132E+00
 1.100E-06     6.945E+00         8.186E+01      2.117E+00     1.411E-01      2.258F+00       1.424E+00
 1.300E-06     7.732E+00         8.505E+01      1.625E+00     1.946E-01      1.819E+00       1.661E+00
 1.600E-06     8.915E+00         8.882E+01      1.778E+00     2.754E-01      2.054E+00       3.831E+00
 2.000E-06     1.049E+01         9.241E+01      1.480E+00     3.811E-01      1.861E+00       4.234E+00
 2.600E-06     1.283E+01         9.573E+01      1.136E+00     5.120E-01      1.648E+00       8.791E+00
 3.500E-06     1.630E+01         9.818E+01      8.713E-01     6.553E-01      1.527E+00       1.044E+01
 5.000E-06     2.203E+01         9.955E+01      3.689E-01     7.615E-01      1.130E+00       1.709E+01
 8.000E-06     3.331E+01         9.997E+01      6.779E-02     7.475E-01      8.153E-01       2.114E+01
 1.500E-05     5.899E+01         1.000E+02      1.077E-02     7.524E-01      7.631E-01       2.887E+01
```

```
                              E.P.A. ESP MODEL
                         I.E.R.L.-R.T.P. AND SO.R.I.

                        SUMMARY TABLE OF ESP OPERATING
                          PARAMETERS AND PERFORMANCE


                              DATA SET NUMBER   1

                       NON-IDEAL CONDITION SET NUMBER  2

 ESP PERFORMANCE:          PENETRATION =   6.1 %

                           EFFICIENCY  =  93.9 %

                           SCA         =  24.6 M2/(M3/SEC)  = 125. FT2/(1000 ACFM)


 ELECTRICAL CONDITIONS:    AVG. APPLIED VOLTAGE =  45.1 KV

                           AVG. CURRENT DENSITY =  25.8 NA/CM2

                           FLY ASH RESISTIVITY  =   1.0E+09 OHM-CM


 SIZE DISTRIBUTIONS:       INLET MMD  =  3.3 UM    INLET SIGMAP  =  2.2

                           OUTLET MMD =  2.3 UM    OUTLET SIGMAP =  2.1


 NON-IDEAL CONDITIONS:     GAS SNEAKAGE FRACTION = 0.10    RAPPING MMD    =  6.0 UM

                           GAS VELOCITY SIGMAG   = 0.10    RAPPING SIGMAP =  2.5
```

APPENDIX B

OUTPUT DATA FROM EXAMPLE 2

```
                    ************************************
                    *                                  *
                    *          E.P.A. ESP MODEL        *
                    *   I.E.R.L.-R.T.P. AND SO.R.I.    *
                    *           REVISION III           *
                    *                                  *
                    ************************************

PRINTOUT OF INPUT DATA FOR DATA SET NUMBER  1


>>>>> CHECK VALUE OF DL
>>>>> CHECK VALUE OF AS( 1)
>>>>> CHECK VALUE OF TEMPS( 1)
>>>>> CHECK VALUE OF LINCS( 1)
>>>>> CHECK VALUE OF TCS( 1)
>>>>> CHECK VALUE OF AS( 2)
>>>>> CHECK VALUE OF TEMPS( 2)
>>>>> CHECK VALUE OF LINCS( 2)
>>>>> CHECK VALUE OF TCS( 2)
>>>>> CHECK VALUE OF TEMPS( 3)
>>>>> CHECK VALUE OF LINCS( 3)

 DATA ON CARD NUMBER   1

 NENDPT = 16   NDATA =  1   NRAP =  0   MODL =  0   NOPRNT =  0   PATHL =  0.00 FT   NCOMPS =  0   NWAVES =  0  NLAMDA =  0

 DATA ON CARD NUMBER   2

 LAB ESP: SCA=82FT2/1000ACFM;CALCULATED V-I FOR EACH ELECTRICAL SECTION

 DATA ON CARD NUMBER   3

 NEST =  1  NDIST =  1  NVI =  2  NX = 15  NY = 15  NITER =  1  NCALC =  0  NRAPD =  1  NEFF =  1  NTEMP =  1  NUMID =  2

 DATA ON CARD NUMBER   4
```

```
NN =  5

DATA ON CARD NUMBER   5

IFINAL = 20  JI1 =  2  JI2 = 21  VISKIP = 1  VISAME =  2

DATA ON CARD NUMBER   6

DL =  0,06500 GRN/ACF  PL =  10,0000 FT  ETAO = 99,00000 %  DD =  1000,00 KG/M**3  EPS =  5,100E+00
VRATIO =   1,0300  US =  ,000165 M**2/V-SEC  FPATH =   1,0000  EBD = 1500000, V/M  RHOCGS =  1,00E+09 OHM-CM

DATA ON CARD NUMBER   7

ASNUCK( 1) =  ,00  AZIGGY( 1) =  ,00  AZNUMS( 1) =  4,0
ASNUCK( 2) =  ,10  AZIGGY( 2) =  ,10  AZNUMS( 2) =  4,0


DATA ON CARD NUMBER   8

ENDPT( 1) =    0,200 UM   ENDPT( 2) =    0,300 UM   ENDPT( 3) =    0,400 UM   ENDPT( 4) =    0,500 UM   ENDPT( 5) =    0,600 UM
ENDPT( 6) =    0,800 UM   ENDPT( 7) =    1,000 UM   ENDPT( 8) =    1,200 UM   ENDPT( 9) =    1,400 UM   ENDPT(10) =    1,800 UM


DATA ON CARD NUMBER   9

ENDPT(11) =    2,200 UM   ENDPT(12) =    3,000 UM   ENDPT(13) =    4,000 UM   ENDPT(14) =    6,000 UM   ENDPT(15) =   10,000 UM
ENDPT(16) =   20,000 UM

DATA ON CARD NUMBER  10

PRCU( 1) =   0,0000 %   PRCU( 2) =   0,0076 %   PRCU( 3) =   0,0563 %   PRCU( 4) =   0,2682 %   PRCU( 5) =   0,8652 %
PRCU( 6) =   2,9845 %   PRCU( 7) =   5,9695 %   PRCU( 8) =   9,5515 %   PRCU( 9) =  12,8350 %   PRCU(10) =  19,7004 %


DATA ON CARD NUMBER  11

PRCU(11) =  26,8643 %   PRCU(12) =  38,8042 %   PRCU(13) =  49,2516 %   PRCU(14) =  64,1765 %   PRCU(15) =  79,1014 %
PRCU(16) = 100,0000 %
```

```
DATA ON CARD NUMBER  12

NUMSEC =  3   LSECT( 1) =  6  LSECT( 2) =  6  LSECT( 3) = 12

DATA ON CARD NUMBER  13

AS( 1) =  6,2500E+00 FT**2  VOS( 1) =  4,0800E+04 V  TCS( 1) =  6,2500E-05 A  WLS( 1) =  6,2500E+00 FT
ACS( 1) =  4,6875E-02 IN  BS( 1) =  5,0000E+00 IN  NWS( 1) =  5,0000E+00

DATA ON CARD NUMBER  14

SYS( 1) =  2,5000E+00 IN  VGS( 1) =  3,0533E+02 FT**3/MIN  VGASS( 1) =  4,8853E+00 FT/SEC  TEMPS( 1) =  7,6000E+01 F
PS( 1) =  1,0000E+00 ATM  VISS( 1) =  1,8000E-05 KG/M-SEC  LINCS( 1) =  4,1667E-01 FT

DATA ON CARD NUMBER  15

RFS( 1) =  9,0000E-01  START1( 1) =  6,0000E-05 A/M**2  START2( 1) =  2,0000E-05 A/M**2
START3( 1) =  2,0000E-05 A/M**2  VSTAR( 1) =  3,8000E+04 V

DATA ON CARD NUMBER  16

AS( 2) =  6,2500E+00 FT**2  VOS( 2) =  4,0800E+04 V  TCS( 2) =  6,2500E-05 A  WLS( 2) =  6,2500E+00 FT
ACS( 2) =  4,6875E-02 IN  BS( 2) =  5,0000E+00 IN  NWS( 2) =  5,0000E+00

DATA ON CARD NUMBER  17

SYS( 2) =  2,5000E+00 IN  VGS( 2) =  3,0533E+02 FT**3/MIN  VGASS( 2) =  4,8853E+00 FT/SEC  TEMPS( 2) =  7,6000E+01 F
PS( 2) =  1,0000E+00 ATM  VISS( 2) =  1,8000E-05 KG/M-SEC  LINCS( 2) =  4,1667E-01 FT

DATA ON CARD NUMBER  18

RFS( 2) =  9,0000E-01  START1( 2) =  6,0000E-05 A/M**2  START2( 2) =  2,0000E-05 A/M**2
START3( 2) =  2,0000E-05 A/M**2  VSTAR( 2) =  3,8000E+04 V

DATA ON CARD NUMBER  19

AS( 3) =  1,2500E+01 FT**2  VOS( 3) =  3,9600E+04 V  TCS( 3) =  1,2500E-04 A  WLS( 3) =  1,2500E+01 FT
ACS( 3) =  4,6875E-02 IN  BS( 3) =  5,0000E+00 IN  NWS( 3) =  1,0000E+01
```

```
DATA ON CARD NUMBER  20

SYS( 3) =  2,5000E+00 IN  VGS( 3) =  3,0533E+02 FT**3/MIN  VGASS( 3) =  4,8853E+00 FT/SEC  TEMPS( 3) =  7,6000E+01 F

PS( 3) =  1,0000E+00 ATM  VISS( 3) =  1,8000E-05 KG/M-SEC  LINCS( 3) =  4,1667E-01 FT

DATA ON CARD NUMBER  21

RFS( 3) =  9,0000E-01  START1( 3) =  6,0000E-05 A/M**2  START2( 3) =  2,0000E-05 A/M**2

START3( 3) =  2,0000E-05 A/M**2  VSTAR( 3) =  3,8000E+04 V
```

```
              CLEAN GAS VOLTAGE-CURRENT DENSITY-FIELD AT THE PLATE RELATIONSHIP FOR SECTION NO.  1

                         VW = -3,7770E+04  ACDNTY =  6,0536E-05  AEPLT = -1,7985E+05
                         VW = -3,8402E+04  ACDNTY =  8,0797E-05  AEPLT = -1,8904E+05
                         VW = -3,8875E+04  ACDNTY =  1,0043E-04  AEPLT = -1,9661E+05
                         VW = -3,9266E+04  ACDNTY =  1,1968E-04  AEPLT = -2,0352E+05
                         VW = -3,9620E+04  ACDNTY =  1,3864E-04  AEPLT = -2,1002E+05
                         VW = -4,0206E+04  ACDNTY =  1,5869E-04  AEPLT = -2,1761E+05
                         VW = -4,0761E+04  ACDNTY =  1,7837E-04  AEPLT = -2,2447E+05
                         VW = -4,1311E+04  ACDNTY =  1,9832E-04  AEPLT = -2,3130E+05
                         VW = -4,0800E+04  ACDNTY =  1,8070E-04  AEPLT = -2,2733E+05


INCREMENTAL ANALYSIS OF PRECIPITATOR PERFORMANCE


LAB ESP: SCA=62FT2/1000ACFM/CALCULATED V-I FOR EACH ELECTRICAL SECTION

CALCULATION IS IN SECTION NO, = 1 AND THE SECTION LENGTH IS =  0,7625 M

                                          APPLIED VOLTAGE =  4,080E+04 VOLTS        TOTAL CURRENT =  1,050E-04 AMPS
COLLECTION AREA =  5,813E-01 M2           CORONA WIRE RADIUS =  1,191E-03 M         CORONA WIRE LENGTH =  1,906E+00 M
WIRE TO PLATE =  1,270E-01 M              CURRENT DENSITY =  1,807E-04 AMP/M2       DEPOSIT E FIELD =  1,807E+03 VOLT/M
CURRENT/M =  5,510E-05 AMP/M              GAS FLOW RATE =  1,444E-01 M3/SEC         GAS VELOCITY =  1,490E+00 M/SEC
1/2 WIRE TO WIRE =  6,350E-02 M           PRESSURE =   1,000 ATM                    VISCOSITY =  1,800E-05 KG/M-SEC
TEMPERATURE = 297,222 K                   MEAN THERMAL SPEED =  4,436E+02 M/SEC     PART. PATH PARAM, =  5,700E-08 M
ION MOBILITY =  1,795E-04 M2/VOLT-SEC     LENGTH INCR, = ,12708435 M                INPUT EFF,/INCR, = 17,46
DUST WEIGHT =  2,150E-05 KG/SEC

                                                                                                    J(ION)   INCR, NO,
RIOVR    ERAVG       EPLT        AFID        CMCD     MMD        WEIGHT     DUST LAYER  J(PART)
                                                                                                     
 ,8219   2,113E+05  2,2733E+05  2,2728E+13   14,9   8,27E-06   8,657E-06   7,922E-04   6,04E-08    1,81E-04     1
 ,7275   2,113E+05  2,2733E+05  2,2739E+13   13,1   4,93E-06   1,404E-05   1,256E-03   1,44E-07    1,81E-04     2
 ,7079   2,113E+05  2,2733E+05  2,2740E+13   12,8   3,20E-06   1,322E-05   1,183E-03   1,71E-07    1,81E-04     3
 ,7069   2,113E+05  2,2733E+05  2,2740E+13   12,8   2,29E-06   1,124E-05   1,006E-03   1,69E-07    1,81E-04     4
 ,7104   2,113E+05  2,2733E+05  2,2740E+13   12,8   1,85E-06   9,567E-06   8,558E-04   1,63E-07    1,81E-04     5
 ,7157   2,113E+05  2,2733E+05  2,2741E+13   12,9   1,55E-06   8,200E-06   7,335E-04   1,55E-07    1,81E-04     6

              CLEAN GAS VOLTAGE-CURRENT DENSITY-FIELD AT THE PLATE RELATIONSHIP FOR SECTION NO.  2

                         VW = -4,0933E+04  ACDNTY =  1,8038E-04  AEPLT = -2,2680E+05
                         VW = -4,0800E+04  ACDNTY =  1,7202E-04  AEPLT = -2,2421E+05

CALCULATION IS IN SECTION NO, = 2 AND THE SECTION LENGTH IS =  0,7625 M

                                          APPLIED VOLTAGE =  4,080E+04 VOLTS        TOTAL CURRENT =  9,999E-05 AMPS
COLLECTION AREA =  5,813E-01 M2           CORONA WIRE RADIUS =  1,191E-03 M         CORONA WIRE LENGTH =  1,906E+00 M
WIRE TO PLATE =  1,270E-01 M              CURRENT DENSITY =  1,720E-04 AMP/M2       DEPOSIT E FIELD =  1,720E+03 VOLT/M
CURRENT/M =  5,245E-05 AMP/M              GAS FLOW RATE =  1,444E-01 M3/SEC         GAS VELOCITY =  1,490E+00 M/SEC
1/2 WIRE TO WIRE =  6,350E-02 M           PRESSURE =   1,000 ATM                    VISCOSITY =  1,800E-05 KG/M-SEC
TEMPERATURE = 297,222 K                   MEAN THERMAL SPEED =  4,436E+02 M/SEC     PART. PATH PARAM, =  5,700E-08 M
ION MOBILITY =  1,795E-04 M2/VOLT-SEC     LENGTH INCR, = ,12708435 M                INPUT EFF,/INCR, = 17,46
DUST WEIGHT =  2,150E-05 KG/SEC
```

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RIOVR     EMAVG        EPLT        AFID       CMCD      MMD         WEIGHT      DUST LAYER   J(PART)      J(ION)    INCR. NO.

 ,7138   2,105E+05  2,2421E+05  2,2096E+13    12,3   1,36E-06    6,999E-06    6,260E-04   1,45E-07     1,72E-04      7
 ,7204   2,105E+05  2,2421E+05  2,2096E+13    12,4   1,21E-06    6,115E-06    5,469E-04   1,38E-07     1,72E-04      8
 ,7272   2,105E+05  2,2421E+05  2,2096E+13    12,5   1,08E-06    5,387E-06    4,818E-04   1,31E-07     1,72E-04      9
 ,7342   2,105E+05  2,2421E+05  2,2096E+13    12,6   9,90E-07    4,783E-06    4,278E-04   1,25E-07     1,72E-04     10
 ,7411   2,105E+05  2,2421E+05  2,2096E+13    12,8   9,21E-07    4,275E-06    3,824E-04   1,19E-07     1,72E-04     11
 ,7480   2,105E+05  2,2421E+05  2,2096E+13    12,9   8,57E-07    3,844E-06    3,438E-04   1,13E-07     1,72E-04     12

                CLEAN GAS VOLTAGE-CURRENT DENSITY-FIELD AT THE PLATE RELATIONSHIP FOR SECTION NO.  3

                         VW = -4,0630E+04  ACDNTY =  1,7126E-04  AEPLT = -2,2352E+05
                         VW = -3,9600E+04  ACDNTY =  1,1435E-04  AEPLT = -2,0472E+05

CALCULATION IS IN SECTION NO. = 3 AND THE SECTION LENGTH IS =  1,5250 M

COLLECTION AREA =  1,163E+00 M2         APPLIED VOLTAGE =  3,960E+04 VOLTS       TOTAL CURRENT =  1,329E-04 AMPS
WIRE TO PLATE =  1,270E-01 M            CORONA WIRE RADIUS =  1,191E-03 M        CORONA WIRE LENGTH =  3,813E+00 M
CURRENT/M =  3,487E-05 AMP/M            CURRENT DENSITY =  1,143E-04 AMP/M2      DEPOSIT E FIELD =  1,143E+03 VOLT/M
1/2 WIRE TO WIRE =  6,350E-02 M         GAS FLOW RATE =  1,444E-01 M3/SEC        GAS VELOCITY =  1,490E+00 M/SEC
TEMPERATURE = 297,222 K                 PRESSURE =   1,000 ATM                   VISCOSITY =  1,800E-05 KG/M-SEC
ION MOBILITY =  1,795E-04 M2/VOLT-SEC  MEAN THERMAL SPEED =  4,436E+02 M/SEC    PART. PATH PARAM. =  5,700E-08 M
DUST WEIGHT =  2,150E-05 KG/SEC         LENGTH INCR. = ,12708435 M               INPUT EFF./INCR. = 17,46

RIOVR     EMAVG        EPLT        AFID       CMCD      MMD         WEIGHT      DUST LAYER   J(PART)      J(ION)    INCR. NO.

 ,6640   2,011E+05  2,0472E+05  1,6767E+13     7,8   7,82E-07    3,165E-06    2,849E-04   9,82E-08     1,14E-04     13
 ,6920   2,011E+05  2,0472E+05  1,6767E+13     7,9   7,45E-07    2,911E-06    2,604E-04   9,35E-08     1,14E-04     14
 ,7000   2,011E+05  2,0472E+05  1,6767E+13     8,0   7,15E-07    2,669E-06    2,367E-04   8,88E-08     1,14E-04     15
 ,7079   2,011E+05  2,0472E+05  1,6767E+13     8,1   6,88E-07    2,455E-06    2,196E-04   8,45E-08     1,14E-04     16
 ,7157   2,011E+05  2,0472E+05  1,6767E+13     8,2   6,64E-07    2,266E-06    2,026E-04   8,04E-08     1,14E-04     17
 ,7233   2,011E+05  2,0472E+05  1,6767E+13     8,3   6,44E-07    2,096E-06    1,875E-04   7,66E-08     1,14E-04     18
 ,7308   2,011E+05  2,0472E+05  1,6767E+13     8,4   6,27E-07    1,945E-06    1,739E-04   7,30E-08     1,14E-04     19
 ,7381   2,011E+05  2,0472E+05  1,6767E+13     8,4   6,12E-07    1,808E-06    1,617E-04   6,96E-08     1,14E-04     20
 ,7452   2,011E+05  2,0472E+05  1,6767E+13     8,5   6,00E-07    1,684E-06    1,507E-04   6,64E-08     1,14E-04     21
 ,7521   2,011E+05  2,0472E+05  1,6767E+13     8,6   5,89E-07    1,572E-06    1,406E-04   6,34E-08     1,14E-04     22
 ,7588   2,011E+05  2,0472E+05  1,6767E+13     8,7   5,80E-07    1,470E-06    1,315E-04   6,06E-08     1,14E-04     23
 ,7654   2,011E+05  2,0472E-05  1,6767E+13     8,8   5,72E-07    1,377E-06    1,231E-04   5,80E-08     1,14E-04     24

DESIGN EFFICIENCY = 99,00      UNCORRECTED COMPUTED EFFICIENCY = 81,94
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CHARGING RATES FOR PARTICLE SIZES FROM SUBROUTINE CHARGN OR CHGSUM

SRI THEORY USED FOR PARTICLE CHARGING

INCREMENT NO.     Q/QSATF FOR INDICATED PARTICLE SIZES

     0.2500E-06    0.3500E-06    0.4500E-06    0.5500E-06    0.7000E-06    0.9000E-06    0.1100E-05    0.1300E-05
 1   1.1010        1.0761        1.0361        0.9978        0.9494        0.8980        0.8609        0.8336
 2   1.3661        1.3216        1.2705        1.2260        1.1735        1.1238        1.0862        1.0564
 3   1.5104        1.4508        1.3889        1.3364        1.2753        1.2180        1.1773        1.1476
 4   1.6094        1.5383        1.4680        1.4091        1.3409        1.2775        1.2332        1.2016
 5   1.6846        1.6043        1.5271        1.4631        1.3893        1.3207        1.2733        1.2396
 6   1.7452        1.6571        1.5742        1.5059        1.4274        1.3546        1.3044        1.2690
 7   1.7937        1.6993        1.6117        1.5398        1.4575        1.3813        1.3289        1.2919
 8   1.8356        1.7356        1.6439        1.5690        1.4833        1.4040        1.3496        1.3112
 9   1.8725        1.7675        1.6721        1.5945        1.5058        1.4238        1.3676        1.3279
10   1.9054        1.7960        1.6973        1.6171        1.5257        1.4413        1.3835        1.3426
11   1.9351        1.8216        1.7199        1.6374        1.5437        1.4570        1.3977        1.3558
12   1.9622        1.8449        1.7404        1.6559        1.5599        1.4712        1.4106        1.3677
13   1.9781        1.8583        1.7520        1.6661        1.5686        1.4787        1.4171        1.3736
14   1.9932        1.8710        1.7629        1.6758        1.5770        1.4858        1.4171        1.3736
15   2.0076        1.8831        1.7734        1.6851        1.5849        1.4858        1.4171        1.3736
16   2.0213        1.8946        1.7834        1.6939        1.5925        1.4858        1.4171        1.3736
17   2.0345        1.9057        1.7929        1.7024        1.5925        1.4858        1.4171        1.3736
18   2.0470        1.9163        1.8021        1.7024        1.5925        1.4858        1.4171        1.3736
19   2.0591        1.9264        1.8109        1.7024        1.5925        1.4858        1.4171        1.3736
20   2.0707        1.9362        1.8109        1.7024        1.5925        1.4858        1.4171        1.3736
21   2.0819        1.9456        1.8109        1.7024        1.5925        1.4858        1.4171        1.3736
22   2.0926        1.9456        1.8109        1.7024        1.5925        1.4858        1.4171        1.3736
23   2.1030        1.9456        1.8109        1.7024        1.5925        1.4858        1.4171        1.3736
24   2.1030        1.9456        1.8109        1.7024        1.5925        1.4858

     0.1600E-05    0.2000E-05    0.2600E-05    0.3500E-05    0.5000E-05    0.8000E-05    0.1500E-04
 1   0.8032        0.7755        0.7524        0.7390        0.7410        0.7851        0.9292
 2   1.0266        1.0061        0.9992        1.0154        1.0814        1.1395        1.1555
 3   1.1194        1.1014        1.0966        1.1086        1.1375        1.1621        1.1668
 4   1.1714        1.1511        1.1427        1.1477        1.1631        1.1749        1.1734
 5   1.2072        1.1845        1.1726        1.1723        1.1796        1.1837        1.1781
 6   1.2345        1.2095        1.1946        1.1901        1.1917        1.1905        1.1781
 7   1.2556        1.2288        1.2113        1.2035        1.2010        1.1960        1.1781
 8   1.2733        1.2448        1.2251        1.2146        1.2087        1.1960        1.1781
 9   1.2886        1.2585        1.2369        1.2240        1.2153        1.1960        1.1781
10   1.3020        1.2705        1.2471        1.2321        1.2210        1.1960        1.1781
11   1.3139        1.2811        1.2561        1.2393        1.2210        1.1960        1.1781
12   1.3246        1.2906        1.2642        1.2457        1.2210        1.1960        1.1781
13   1.3298        1.2950        1.2676        1.2481        1.2210        1.1960        1.1781
14   1.3298        1.2950        1.2676        1.2481        1.2210        1.1960        1.1781
15   1.3298        1.2950        1.2676        1.2481        1.2210        1.1960        1.1781
16   1.3298        1.2950        1.2676        1.2481        1.2210        1.1960        1.1781
17   1.3298        1.2950        1.2676        1.2481        1.2210        1.1960        1.1781
18   1.3298        1.2950        1.2676        1.2481        1.2210        1.1960        1.1781
19   1.3298        1.2950        1.2676        1.2481        1.2210        1.1960        1.1781
20   1.3298        1.2950        1.2676        1.2481        1.2210        1.1960        1.1781
21   1.3298        1.2950        1.2676        1.2481        1.2210        1.1960        1.1781
```

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22  1.3298      1.2950      1.2676      1.2481      1.2210      1.1960      1.1781
23  1.3298      1.2950      1.2676      1.2481      1.2210      1.1960      1.1781
24  1.3298      1.2950      1.2676      1.2481      1.2210      1.1960      1.1781
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  CHARGE ACCUMULATED ON PARTICLE SIZES IN EACH INCREMENT

INCREMENT        CHARGE FOR INDICATED PARTICLE SIZES


      0.2500E-06    0.3500E-06    0.4500E-06    0.5500E-06    0.7000E-06    0.9000E-06    0.1100E-05    0.1300E-05
  1  0.16819E-17   0.32531E-17   0.49093E-17   0.68411E-17   0.10244E-16   0.15669E-16   0.22146E-16   0.29690E-16
  2  0.23352E-17   0.39954E-17   0.60200E-17   0.84053E-17   0.12661E-16   0.19608E-16   0.27941E-16   0.37626E-16
  3  0.25618E-17   0.43800E-17   0.65811E-17   0.91624E-17   0.13759E-16   0.21253E-16   0.30286E-16   0.40876E-16
  4  0.27510E-17   0.46504E-17   0.69555E-17   0.96607E-17   0.14468E-16   0.22290E-16   0.31723E-16   0.42797E-16
  5  0.28796E-17   0.48499E-17   0.72357E-17   0.10031E-16   0.14990E-16   0.23044E-16   0.32754E-16   0.44154E-16
  6  0.29831E-17   0.50097E-17   0.74591E-17   0.10325E-16   0.15401E-16   0.23635E-16   0.33556E-16   0.45199E-16
  7  0.30661E-17   0.51372E-17   0.76366E-17   0.10557E-16   0.15726E-16   0.24101E-16   0.34184E-16   0.46014E-16
  8  0.31377E-17   0.52470E-17   0.77892E-17   0.10757E-16   0.16004E-16   0.24497E-16   0.34716E-16   0.46702E-16
  9  0.32007E-17   0.53435E-17   0.79230E-17   0.10932E-16   0.16247E-16   0.24842E-16   0.35181E-16   0.47298E-16
 10  0.32570E-17   0.54294E-17   0.80420E-17   0.11087E-16   0.16462E-16   0.25148E-16   0.35589E-16   0.47823E-16
 11  0.33078E-17   0.55069E-17   0.81491E-17   0.11226E-16   0.16655E-16   0.25422E-16   0.35955E-16   0.48291E-16
 12  0.33540E-17   0.55774E-17   0.82465E-17   0.11353E-16   0.16831E-16   0.25670E-16   0.36286E-16   0.48713E-16
 13  0.33812E-17   0.56178E-17   0.83011E-17   0.11423E-16   0.16925E-16   0.25800E-16   0.36455E-16   0.48924E-16
 14  0.34071E-17   0.56563E-17   0.83531E-17   0.11490E-16   0.17015E-16   0.25924E-16   0.36455E-16   0.48924E-16
 15  0.34317E-17   0.56928E-17   0.84027E-17   0.11553E-16   0.17101E-16   0.25924E-16   0.36455E-16   0.48924E-16
 16  0.34551E-17   0.57276E-17   0.84500E-17   0.11614E-16   0.17183E-16   0.25924E-16   0.36455E-16   0.48924E-16
 17  0.34775E-17   0.57612E-17   0.84953E-17   0.11671E-16   0.17183E-16   0.25924E-16   0.36455E-16   0.48924E-16
 18  0.34990E-17   0.57932E-17   0.85386E-17   0.11671E-16   0.17183E-16   0.25924E-16   0.36455E-16   0.48924E-16
 19  0.35197E-17   0.58239E-17   0.85803E-17   0.11671E-16   0.17183E-16   0.25924E-16   0.36455E-16   0.48924E-16
 20  0.35395E-17   0.58535E-17   0.85803E-17   0.11671E-16   0.17183E-16   0.25924E-16   0.36455E-16   0.48924E-16
 21  0.35586E-17   0.58819E-17   0.85803E-17   0.11671E-16   0.17183E-16   0.25924E-16   0.36455E-16   0.48924E-16
 22  0.35769E-17   0.58819E-17   0.85803E-17   0.11671E-16   0.17183E-16   0.25924E-16   0.36455E-16   0.48924E-16
 23  0.35947E-17   0.58819E-17   0.85803E-17   0.11671E-16   0.17183E-16   0.25924E-16   0.36455E-16   0.48924E-16
 24  0.35947E-17   0.58819E-17   0.85803E-17   0.11671E-16   0.17183E-16   0.25924E-16   0.36455E-16   0.48924E-16

      0.1600E-05    0.2000E-05    0.2600E-05    0.3500E-05    0.5000E-05    0.8000E-05    0.1500E-04
  1  0.42963E-16   0.64360E-16   0.10486E-15   0.18569E-15   0.37835E-15   0.10224E-14   0.42426E-14
  2  0.54916E-16   0.83498E-16   0.13926E-15   0.25514E-15   0.55213E-15   0.14839E-14   0.52758E-14
  3  0.59879E-16   0.91401E-16   0.15284E-15   0.27855E-15   0.58078E-15   0.15134E-14   0.53276E-14
  4  0.62660E-16   0.95532E-16   0.15927E-15   0.28838E-15   0.59382E-15   0.15300E-14   0.53576E-14
  5  0.64578E-16   0.98305E-16   0.16343E-15   0.29455E-15   0.60224E-15   0.15416E-14   0.53791E-14
  6  0.66036E-16   0.10038E-15   0.16649E-15   0.29901E-15   0.60643E-15   0.15504E-14   0.53791E-14
  7  0.67165E-16   0.10197E-15   0.16882E-15   0.30239E-15   0.61319E-15   0.15575E-14   0.53791E-14
  8  0.68114E-16   0.10330E-15   0.17074E-15   0.30517E-15   0.61714E-15   0.15575E-14   0.53791E-14
  9  0.68931E-16   0.10444E-15   0.17238E-15   0.30753E-15   0.62050E-15   0.15575E-14   0.53791E-14
 10  0.69647E-16   0.10544E-15   0.17361E-15   0.30957E-15   0.62342E-15   0.15575E-14   0.53791E-14
 11  0.70284E-16   0.10632E-15   0.17507E-15   0.31137E-15   0.62342E-15   0.15575E-14   0.53791E-14
 12  0.70858E-16   0.10711E-15   0.17619E-15   0.31298E-15   0.62342E-15   0.15575E-14   0.53791E-14
 13  0.71133E-16   0.10747E-15   0.17667E-15   0.31359E-15   0.62342E-15   0.15575E-14   0.53791E-14
 14  0.71133E-16   0.10747E-15   0.17667E-15   0.31359E-15   0.62342E-15   0.15575E-14   0.53791E-14
 15  0.71133E-16   0.10747E-15   0.17667E-15   0.31359E-15   0.62342E-15   0.15575E-14   0.53791E-14
 16  0.71133E-16   0.10747E-15   0.17667E-15   0.31359E-15   0.62342E-15   0.15575E-14   0.53791E-14
 17  0.71133E-16   0.10747E-15   0.17667E-15   0.31359E-15   0.62342E-15   0.15575E-14   0.53791E-14
 18  0.71133E-16   0.10747E-15   0.17667E-15   0.31359E-15   0.62342E-15   0.15575E-14   0.53791E-14
 19  0.71133E-16   0.10747E-15   0.17667E-15   0.31359E-15   0.62342E-15   0.15575E-14   0.53791E-14
 20  0.71133E-16   0.10747E-15   0.17667E-15   0.31359E-15   0.62342E-15   0.15575E-14   0.53791E-14
 21  0.71133E-16   0.10747E-15   0.17667E-15   0.31359E-15   0.62342E-15   0.15575E-14   0.53791E-14
 22  0.71133E-16   0.10747E-15   0.17667E-15   0.31359E-15   0.62342E-15   0.15575E-14   0.53791E-14
 23  0.71133E-16   0.10747E-15   0.17667E-15   0.31359E-15   0.62342E-15   0.15575E-14   0.53791E-14
 24  0.71133E-16   0.10747E-15   0.17667E-15   0.31359E-15   0.62342E-15   0.15575E-14   0.53791E-14
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PARTICLE SIZE RANGE STATISTICS

CORRECTIONS FOR NONIDEALITIES USING SET NO.  1 OF CORRECTION PARAMETERS

   SIZE       CCF   INLET % OUTLET % COR. OUTLET % NO-RAP EFF. NO-RAP W  NO-RAP P  COR. EFF.   COR. W    COR. P
 2.500E-07   1.589   0.008   0.0234      0.0268       61.0610     5.859   38.9390   46.6117    3.898    53.3883
 3.500E-07   1.414   0.049   0.1517      0.1435       60.6397     5.792   39.3603   55.3532    5.009    44.6468
 4.500E-07   1.320   0.212   0.6512      0.5726       61.1715     5.876   38.8285   59.0515    5.546    40.9485
 5.500E-07   1.261   0.597   1.7820      1.5298       62.2838     6.057   37.7162   61.1693    5.876    38.8307
 7.000E-07   1.205   2.119   6.0355      5.1645       64.0161     6.349   35.9839   63.0710    6.188    36.9290
 9.000E-07   1.159   2.985   7.8998      6.7751       66.5604     6.804   33.4396   65.6048    6.629    34.3952
 1.100E-06   1.130   3.582   8.8064      7.5794       68.9356     7.262   31.0644   67.9345    7.065    32.0655
 1.300E-06   1.110   3.284   7.4674      6.5024       71.2642     7.746   28.7358   69.9900    7.477    30.0100
 1.600E-06   1.090   6.865  14.0028     12.3122       74.2267     8.422   25.7713   72.8231    8.093    27.1769
 2.000E-06   1.072   7.164  12.6377     11.2409       77.7102     9.324   22.2898   76.2217    8.922    23.7783
 2.600E-06   1.055  11.940  17.0320     15.6624       81.9759    10.643   18.0241   80.1214   10.035    19.8786
 3.500E-06   1.041  10.447  11.2387     11.1056       86.4076    12.396   13.5924   83.8913   11.341    16.1087
 5.000E-06   1.029  14.925   9.7550     10.9746       91.7415    15.491    8.2585   88.8569   13.631    11.1431
 8.000E-06   1.018  14.925   2.3914      5.5074       97.9755    24.224    2.0245   94.4080   17.913     5.5920
 1.500E-05   1.010  20.899   0.1249      4.9028       99.9245    44.656    0.0755   96.4449   20.727     3.5551

EFFICIENCIES FOR CONVERGENCE CHECK:  STATED OR PREVIOUS CALCULATION =  99.000   FINAL CALCULATION =  81.942


   ADJUSTED NO-RAP EFF. =  87.3646
   MMD OF INLET SIZE DISTRIBUTION =  3.987E+00
   SIGMAP OF INLET SIZE DISTRIBUTION =  2.165E+00
   LOG-NORMAL GOODNESS OF FIT =  0.985
   MMD OF EFFLUENT UNDER NO-RAP CONDITIONS =  1.907E+00
   SIGMAP OF EFFLUENT UNDER NO-RAP CONDITIONS =  1.760E+00
   LOG-NORMAL GOODNESS OF FIT =  0.997
   PRECIPITATION RATE PARAMETER UNDER NO-RAP CONDITIONS = 12.850


   SIGMAG=    0.000  WITH  0.000 SNEAKAGE OVER    4.000  STAGES
   NTEMP = 1
   RMMD =  6.00
   RSIGMA = 2.50
   CORR. EFF. =  84.8460
   CORRECTED MMD OF EFFLUENT =  2.385E+00
   CORRECTED SIGMAP OF EFFLUENT =  1.964E+00
   LOG-NORMAL GOODNESS OF FIT =  0.988
   CORRECTED PRECIPITATION RATE PARAMETER =   11.72
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UNADJUSTED MIGRATION VELOCITIES AND EFFICIENCIES, AND DISCRETE OUTLET MASS LOADINGS

IDEAL UNADJUSTED   IDEAL UNADJUSTED     NO-RAP      RAPPING PUFF   NO-RAP+RAP PUFF   RAPPING PUFF   PARTICLE
   MIG. VEL.          EFFICIENCY       DM/DLOGD      DM/DLOGD         DM/DLOGD       DISTRIBUTION     DIAM.
   (CM/SEC)              (%)          (MG/DSCM)     (MG/DSCM)        (MG/DSCM)           (%)           (M)
   2.520E+00          3.335E+01       2.729E-02     1.013E-02        3.741E-02        4.360E-02     2.500E-07
   2.669E+00          3.493E+01       2.491E-01     3.346E-02        2.826E-01        1.022E-01     3.500E-07
   2.867E+00          3.696E+01       1.378E+00     7.527E-02        1.454E+00        1.784E-01     4.500E-07
   3.082E+00          3.912E+01       4.617E+00     1.364E-01        4.754E+00        2.642E-01     5.500E-07
   3.432E+00          4.245E+01       9.910E+00     2.603E-01        1.017E+01        7.953E-01     7.000E-07
   3.911E+00          4.672E+01       1.672E+01     4.779E-01        1.720E+01        1.132E+00     9.000E-07
   4.407E+00          5.081E+01       2.282E+01     7.354E-01        2.355E+01        1.424E+00     1.100E-06
   4.921E+00          5.472E+01       2.288E+01     1.015E+00        2.390E+01        1.661E+00     1.300E-06
   5.714E+00          6.014E+01       2.632E+01     1.435E+00        2.776E+01        3.631E+00     1.600E-06
   6.806E+00          6.657E+01       2.975E+01     1.967E+00        3.174E+01        4.234E+00     2.000E-06
   8.501E+00          7.455E+01       2.594E+01     2.669E+00        2.861E+01        8.791E+00     2.600E-06
   1.112E+01          8.330E+01       1.845E+01     3.416E+00        2.187E+01        1.044E+01     3.500E-06
   1.549E+01          9.174E+01       1.136E+01     3.970E+00        1.533E+01        1.709E+01     5.000E-06
   2.422E+01          9.798E+01       2.211E+00     3.897E+00        6.108E+00        2.114E+01     8.000E-06
   4.466E+01          9.992E+01       8.509E-02     3.922E+00        4.007E+00        2.887E+01     1.500E-05
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                         E.P.A. ESP MODEL
                    I.E.R.L.-R.T.P. AND SO.R.I.

                   SUMMARY TABLE OF ESP OPERATING
                     PARAMETERS AND PERFORMANCE


                         DATA SET NUMBER   1

                   NON-IDEAL CONDITION SET NUMBER  1

ESP PERFORMANCE:     EFFICIENCY =  84.8460 %     SCA =  1.610E+01 M**2/(M**3/SEC)
                                                      (  82. FT**2/1000 ACFM)

ELECTRICAL CONDITIONS:     AVG. APPLIED VOLTAGE =  4.020E+04 V
                           AVG. CURRENT DENSITY =   10.60 NA/CM**2
                           RESISTIVITY =  1.000E+09 OHM-CM

SIZE DISTRIBUTIONS:     INLET MMD =  3.987E+00 UM     INLET SIGMAP =  2.165E+00
                        OUTLET MMD =  2.385E+00 UM    OUTLET SIGMAP =  1.964E+00

NONIDEAL PARAMETERS:     GAS SNEAKAGE FRACTION =  .00 /SECTION     GAS VELOCITY SIGMAG =  .00
                         RAPPING MMD =  6.000E+00 UM     RAPPING SIGMAP =  2.500E+00
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PARTICLE SIZE RANGE STATISTICS

CORRECTIONS FOR NONIDEALITIES USING SET NO.  2 OF CORRECTION PARAMETERS

   SIZE      CCF  INLET % OUTLET % COR. OUTLET % NO-RAP EFF. NO-RAP W  NO-RAP P  COR. EFF.    COR. W      COR. P
 2.500E-07  1.589  0.008   0.0206        0.0239      56.7582     5.208   43.2418   41.6974     3.351     58.3026
 3.500E-07  1.414  0.049   0.1335        0.1291      56.3174     5.145   43.6826   50.8071     4.407     49.1929
 4.500E-07  1.320  0.212   0.5742        0.5182      56.8088     5.215   43.1912   54.5991     4.905     45.4009
 5.500E-07  1.261  0.597   1.5779        1.3922      57.8724     5.370   42.1276   56.7108     5.201     43.2892
 7.000E-07  1.205  2.119   5.3806        4.7322      59.5340     5.620   40.4660   58.5489     5.470     41.4511
 9.000E-07  1.159  2.985   7.1171        6.2708      61.9979     6.010   38.0021   61.0019     5.849     38.9981
 1.100E-06  1.130  3.582   8.0206        7.0877      64.3112     6.400   35.6888   63.2677     6.221     36.7323
 1.300E-06  1.110  3.284   6.8814        6.1431      66.5970     6.811   33.4030   65.2088     6.569     34.7912
 1.600E-06  1.090  6.865  13.1279       11.8132      69.5226     7.381   30.4774   68.0576     7.089     31.9424
 2.000E-06  1.072  7.164  12.1364       11.0188      72.9984     8.133   27.0016   71.4469     7.786     28.5531
 2.600E-06  1.055 11.940  16.9847       15.8260      77.3272     9.218   22.6728   75.3942     8.710     24.6058
 3.500E-06  1.041 10.447  11.8572       11.6564      81.9107    10.621   18.0893   79.2879     9.780     20.7121
 5.000E-06  1.029 14.925  11.4866       12.2795      87.7333    13.034   12.2667   84.7266    11.672     15.2734
 8.000E-06  1.018 14.925   3.9853        6.4112      95.7440    19.609    4.2560   92.0256    15.709      7.9744
 1.500E-05  1.010 20.899   0.7159        4.6978      99.4540    32.364    0.5460   95.8271    19.732      4.1729

 EFFICIENCIES FOR CONVERGENCE CHECK:  STATED OR PREVIOUS CALCULATION =  99.000   FINAL CALCULATION =  81.942

    ADJUSTED NO-RAP EFF. =  84.0615
    MMD OF INLET SIZE DISTRIBUTION =  3.987E+00
    SIGMAP OF INLET SIZE DISTRIBUTION =  2.165E+00
    LOG-NORMAL GOODNESS OF FIT =  0.985
    MMD OF EFFLUENT UNDER NO-RAP CONDITIONS =  2.059E+00
    SIGMAP OF EFFLUENT UNDER NO-RAP CONDITIONS =  1.801E+00
    LOG-NORMAL GOODNESS OF FIT =  0.995
    PRECIPITATION RATE PARAMETER UNDER NO-RAP CONDITIONS = 11.407


    SIGMAG=     0.100  WITH  0.100 SNEAKAGE OVER     4.000  STAGES
    NTEMP = 1
    RMMD =  6.00
    RSIGMA = 2.50
    CORR. EFF. =  81.4362
    CORRECTED MMD OF EFFLUENT =  2.458E+00
    CORRECTED SIGMAP OF EFFLUENT =  1.962E+00
    LOG-NORMAL GOODNESS OF FIT =  0.990
    CORRECTED PRECIPITATION RATE PARAMETER =   10.46
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UNADJUSTED MIGRATION VELOCITIES AND EFFICIENCIES, AND DISCRETE OUTLET MASS LOADINGS

IDEAL UNADJUSTED MIG. VEL. (CM/SEC)	IDEAL UNADJUSTED EFFICIENCY (%)	NO-RAP DM/DLOGD (MG/DSCM)	RAPPING PUFF DM/DLOGD (MG/DSCM)	NO-RAP+RAP PUFF DM/DLOGD (MG/DSCM)	RAPPING PUFF DISTRIBUTION (%)	PARTICLE DIAM. (M)
2,520E+00	3,335E+01	3,030E-02	1,055E-02	4,086E-02	4,360E-02	2,500E-07
2,669E+00	3,493E+01	2,765E-01	3.487E-02	3,113E-01	1,022E-01	3,500E-07
2,867E+00	3,696E+01	1,533E+00	7.845E-02	1,612E+00	1,784E-01	4,500E-07
3,082E+00	3,912E+01	5,157E+00	1.422E-01	5,299E+00	2,642E-01	5,500E-07
3,432E+00	4,245E+01	1,114E+01	2,713E-01	1,142E+01	7,953E-01	7,000E-07
3,911E+00	4,672E+01	1,901E+01	4,981E-01	1,950E+01	1,132E+00	9,000E-07
4,407E+00	5,081E+01	2,621E+01	7,665E-01	2,698E+01	1,424E+00	1,100E-06
4,921E+00	5,472E+01	2,660E+01	1,058E+00	2,766E+01	1,661E+00	1,300E-06
5,714E+00	6,014E+01	3,113E+01	1,496E+00	3,262E+01	3,031E+00	1,600E-06
6,806E+00	6,657E+01	3,604E+01	2,071E+00	3,811E+01	4,234E+00	2,000E-06
8,501E+00	7,455E+01	3,263E+01	2,782E+00	3,541E+01	6,791E+00	2,600E-06
1,112E+01	8,330E+01	2,456E+01	3.561E+00	2,812E+01	1,044E+01	3,500E-06
1,549E+01	9,174E+01	1,688E+01	4.138E+00	2,102E+01	1,709E+01	5,000E-06
2,422E+01	9,796E+01	4,649E+00	4,062E+00	6,711E+00	2,114E+01	8,000E-06
4,466E+01	9,992E+01	6,155E-01	4,088E+00	4,704E+00	2,887E+01	1,500E-05

```
******************************************************************************************
*                                                                                        *
*                                E.P.A. ESP MODEL                                        *
*                          I.E.R.L.-R.T.P. AND SO.R.I.                                   *
*                                                                                        *
*                         SUMMARY TABLE OF ESP OPERATING                                 *
*                           PARAMETERS AND PERFORMANCE                                   *
*                                                                                        *
*                                                                                        *
*                              DATA SET NUMBER   1                                       *
*                                                                                        *
*                         NON-IDEAL CONDITION SET NUMBER  2                              *
*                                                                                        *
*   ESP PERFORMANCE:     EFFICIENCY =  81.4362 %     SCA =  1.610E+01 M**2/(M**3/SEC)    *
*                                                         (  82. FT**2/1000 ACFM)        *
*                                                                                        *
*   ELECTRICAL CONDITIONS:     AVG. APPLIED VOLTAGE =  4.020E+04 V                       *
*                              AVG. CURRENT DENSITY =   10.60 NA/CM**2                   *
*                              RESISTIVITY =  1.000E+09 OHM-CM                           *
*                                                                                        *
*   SIZE DISTRIBUTIONS:     INLET MMD =  3.967E+00 UM     INLET SIGMAP =  2.165E+00      *
*                           OUTLET MMD =  2.456E+00 UM    OUTLET SIGMAP =  1.962E+00     *
*                                                                                        *
*   NONIDEAL PARAMETERS:     GAS SNEAKAGE FRACTION =  .10 /SECTION    GAS VELOCITY SIGMAG =  .10
*                            RAPPING MMD =  6.000E+00 UM    RAPPING SIGMAP =  2.500E+00  *
*                                                                                        *
******************************************************************************************
```

APPENDIX C

OUTPUT DATA FROM EXAMPLE 3

```
**************************************
*                                    *
*          E.P.A. ESP MODEL          *
*                                    *
*    I.E.R.L.-R.T.P. AND SO.R.I.     *
*                                    *
*           REVISION III             *
*                                    *
**************************************

PRINTOUT OF INPUT DATA FOR DATA SET NUMBER  1


DATA ON CARD NUMBER   1

NENDPT = 14   NDATA =  1   NRAP =  0   MODL =  0   NOPRNT =  0   PATHL = 17.40 FT   NCOMPS =  0   NWAVES =  0  NLAMDA =  0

DATA ON CARD NUMBER   2

FULL-SCALE,COLD-SIDE ESP:  PLANT A;  SCA=243FT2/1000ACFM; J=15.9UA/FT2

DATA ON CARD NUMBER   3

NEST =  1  NDIST =  1  NVI =  1  NX = 10  NY = 10  NITER =  3  NCALC =  0  NRAPD =  1  NEFF =  1  NTEMP =  1  NUNID =  2

DATA ON CARD NUMBER   4

NN =  5

DATA ON CARD NUMBER   5

DL =  1,96600 GRN/ACF  PL =  27,0000 FT  ETAO = 99,60000 %  DD =  2270,00 KG/M**3  EPS =  1,000E+02
VRATIO =   1,2000  US =  ,000220 M**2/V-SEC  FPATH =   1.0000  EBD = 1500000. V/M  RHOCGS =  5.00E+10 OHM-CM

DATA ON CARD NUMBER   6

ASNUCK( 1) =  ,00  AZIGGY( 1) =  ,00  AZNUMS( 1) =  3,0
ASNUCK( 2) =  ,10  AZIGGY( 2) =  ,25  AZNUMS( 2) =  3,0


DATA ON CARD NUMBER   7
```

```
ENDPT( 1) =    0.100 UM   ENDPT( 2) =    0.300 UM   ENDPT( 3) =    0.500 UM   ENDPT( 4) =    0.900 UM   ENDPT( 5) =    1.300 UM
ENDPT( 6) =    1.900 UM   ENDPT( 7) =    3.100 UM   ENDPT( 8) =    3.900 UM   ENDPT( 9) =    5.100 UM   ENDPT(10) =    6.900 UM


DATA ON CARD NUMBER   8

ENDPT(11) =   10.100 UM   ENDPT(12) =   14.900 UM   ENDPT(13) =   25.100 UM   ENDPT(14) =   29.900 UM

DATA ON CARD NUMBER   9

PRCU( 1) =   0.0000 %   PRCU( 2) =   0.0330 %   PRCU( 3) =   0.2860 %   PRCU( 4) =   1.1890 %   PRCU( 5) =   2.0040 %
PRCU( 6) =   3.5240 %   PRCU( 7) =   7.0480 %   PRCU( 8) =   8.7000 %   PRCU( 9) =  10.3520 %   PRCU(10) =  12.3340 %


DATA ON CARD NUMBER  10

PRCU(11) =  15.6380 %   PRCU(12) =  20.4840 %   PRCU(13) =  32.5990 %   PRCU(14) = 100.0000 %

DATA ON CARD NUMBER  11

NUMSEC =  3    LSECT( 1) = 10  LSECT( 2) = 10  LSECT( 3) = 10

DATA ON CARD NUMBER  12

AS( 1) =  2.6460E+04 FT**2  VOS( 1) =  4.0600E+04 V  TCS( 1) =  2.7300E-01 A  WLS( 1) =  1.5720E+04 FT
ACS( 1) =  8.2500E-02 IN  BS( 1) =  5.5000E+00 IN  NWS( 1) =  1.2000E+01

DATA ON CARD NUMBER  13

SYS( 1) =  3.6250E+00 IN  VGS( 1) =  3.2724E+05 FT**3/MIN  VGASS( 1) =  4.1000E+00 FT/SEC  TEMPS( 1) =  3.1500E+02 F
PS( 1) =  1.0000E+00 ATM  VISS( 1) =  2.2900E-05 KG/M-SEC  LINCS( 1) =  9.0000E-01 FT

DATA ON CARD NUMBER  14

AS( 2) =  2.6460E+04 FT**2  VOS( 2) =  4.2100E+04 V  TCS( 2) =  4.3300E-01 A  WLS( 2) =  1.5720E+04 FT
ACS( 2) =  8.2500E-02 IN  BS( 2) =  5.5000E+00 IN  NWS( 2) =  1.2000E+01

DATA ON CARD NUMBER  15
```

```
SYS( 2) =  3.6250E+00 IN  VGS( 2) =  3.2724E+05 FT**3/MIN  VGASS( 2) =  4.1000E+00 FT/SEC  TEMPS( 2) =  3.1500E+02 F

PS( 2) =  1.0000E+00 ATM  VISS( 2) =  2.2900E-05 KG/M-SEC  LINCS( 2) =  9.0000E-01 FT

DATA ON CARD NUMBER  16

AS( 3) =  2.6460E+04 FT**2  VOS( 3) =  4.2450E+04 V  TCS( 3) =  5.5800E-01 A  WLS( 3) =  1.5720E+04 FT

ACS( 3) =  8.2500E-02 IN  BS( 3) =  5.5000E+00 IN  NWS( 3) =  1.2000E+01

DATA ON CARD NUMBER  17

SYS( 3) =  3.6250E+00 IN  VGS( 3) =  3.2724E+05 FT**3/MIN  VGASS( 3) =  4.1000E+00 FT/SEC  TEMPS( 3) =  3.1500E+02 F

PS( 3) =  1.0000E+00 ATM  VISS( 3) =  2.2900E-05 KG/M-SEC  LINCS( 3) =  9.0000E-01 FT
```

```
INCREMENTAL ANALYSIS OF PRECIPITATOR PERFORMANCE


FULL-SCALE,COLD-SIDE ESP:  PLANT A;  SCA=243FT2/1000ACFM; J=15.90A/FT2


CALCULATION IS IN SECTION NO. = 1 AND THE SECTION LENGTH IS =  2,7450 M

COLLECTION AREA =  2,461E+03 M2        APPLIED VOLTAGE =  4.060E+04 VOLTS        TOTAL CURRENT =  2.730E-01 AMPS
WIRE TO PLATE =  1.397E-01 M           CORONA WIRE RADIUS =  2.095E-03 M         CORONA WIRE LENGTH =  4.795E+03 M
CURRENT/M =  5.694E-05 AMP/M           CURRENT DENSITY =  1.109E-04 AMP/M2       DEPOSIT E FIELD =  5.547E+04 VOLT/M
1/2 WIRE TO WIRE =  9.207E-02 M        GAS FLOW RATE =  1.548E+02 M3/SEC         GAS VELOCITY =  1.251E+00 M/SEC
TEMPERATURE = 430.000 K                PRESSURE =   1.000 ATM                    VISCOSITY =  2.290E-05 KG/M-SEC
ION MOBILITY =  3,463E-04 M2/VOLT-SEC  MEAN THERMAL SPEED =  5.335E+02 M/SEC     PART. PATH PARAM. =  8.246E-08 M
DUST WEIGHT =  6,969E-01 KG/SEC        LENGTH INCR. = .27450000 M                INPUT EFF./INCR. = 16.81

ROVRI     ERAVG       EPLT        AFID        CMCD     MMD        WEIGHT      DUST LAYER   J(PART)     J(ION)    INCR. NO.

3,1566   2.906E+05   2,0951E+05  2,1825E+12   11.1   2,29E-05   1,529E-03   5.771E-02   4,86E-07   1.10E-04      1
2,5155   2.906E+05   1,9809E+05  2,7387E+12   11,1   2,27E-05   1,194E-03   4.505E-02   6.22E-07   1,10E-04      2
2,0575   2.906E+05   1,8908E+05  3,3483E+12   11,1   2.22E-05   6.833E-04   2,579E-02   5.16E-07   1,10E-04      3
1,7616   2.906E+05   1,8373E+05  3,9108E+12   11,1   2.13E-05   3,644E-04   1.375E-02   4,11E-07   1,11E-04      4
1,5639   2.906E+05   1.7950E+05  4,4050E+12   11.1   1.91E-05   1.967E-04   7,425E-03   3,40E-07   1.11E-04      5
1,4253   2.906E+05   1.7673E+05  4,8336E+12   11.1   1.20E-05   1.141E-04   4.305E-03   2.90E-07   1.11E-04      6
1,3241   2.906E+05   1,7448E+05  5,2030E+12   11.1   7.50E-06   7.261E-05   2.740E-03   2,67E-07   1.11E-04      7
1,2485   2.906E+05   1.7278E+05  5,5180E+12   11.1   5.15E-06   5.079E-05   1.917E-03   2,46E-07   1.11E-04      8
1,1912   2.906E+05   1,7154E+05  5,7832E+12   11.1   3,91E-06   3.838E-05   1,448E-03   2.28E-07   1.11E-04      9
1.1476   2.906E+05   1,7055E+05  6,0034E+12   11.1   3,21E-06   3,061E-05   1.155E-03   2,13E-07   1,11E-04     10

CALCULATION IS IN SECTION NO. = 2 AND THE SECTION LENGTH IS =  2.7450 M

COLLECTION AREA =  2,461E+03 M2        APPLIED VOLTAGE =  4.210E+04 VOLTS        TOTAL CURRENT =  4.330E-01 AMPS
WIRE TO PLATE =  1.397E-01 M           CORONA WIRE RADIUS =  2.095E-03 M         CORONA WIRE LENGTH =  4.795E+03 M
CURRENT/M =  9,031E-05 AMP/M           CURRENT DENSITY =  1.760E-04 AMP/M2       DEPOSIT E FIELD =  8.798E+04 VOLT/M
1/2 WIRE TO WIRE =  9.207E-02 M        GAS FLOW RATE =  1,548E+02 M3/SEC         GAS VELOCITY =  1,251E+00 M/SEC
TEMPERATURE = 430.000 K                PRESSURE =   1.000 ATM                    VISCOSITY =  2.290E-05 KG/M-SEC
ION MOBILITY =  3,463E-04 M2/VOLT-SEC  MEAN THERMAL SPEED =  5.335E+02 M/SEC     PART. PATH PARAM. =  8.246E-08 M
DUST WEIGHT =  6,969E-01 KG/SEC        LENGTH INCR. = .27450000 M                INPUT EFF./INCR. = 16,81

ROVRI     ERAVG       EPLT        AFID        CMCD     MMD        WEIGHT      DUST LAYER   J(PART)     J(ION)    INCR. NO.

1,0746   3,014E+05   1,8628E+05  9,8062E+12   17.6   2,71E-06   2,794E-05   1,054E-03   2,24E-07   1.76E-04     11
1,0573   3,014E+05   1,8573E+05  9,9668E+12   17.6   2.42E-06   2,345E-05   8,849E-04   2.12E-07   1.76E-04     12
1,0440   3,014E+05   1,8573E+05  1,0093E+13   17.6   2.29E-06   2,000E-05   7.547E-04   2.00E-07   1.76E-04     13
1,0338   3,014E+05   1,8494E+05  1,0193E+13   17.6   2,19E-06   1.715E-05   6.473E-04   1.87E-07   1.76E-04     14
1,0260   3,014E+05   1,8494E+05  1,0270E+13   17.6   2.09E-06   1.469E-05   5,619E-04   1.75E-07   1.76E-04     15
1,0200   3,014E+05   1.8494E+05  1,0330E+13   17.6   2.01E-06   1,300E-05   4.905E-04   1.64E-07   1.76E-04     16
1,0154   3,014E+05   1,8494E+05  1,0377E+13   17.6   1.94E-06   1.140E-05   4,303E-04   1.53E-07   1.76E-04     17
1,0119   3,014E+05   1,8494E+05  1,0413E+13   17.6   1,87E-06   1,004E-05   3,790E-04   1,44E-07   1.76E-04     18
1,0092   3,014E+05   1,8494E+05  1,0442E+13   17.6   1.80E-06   8,876E-06   3,350E-04   1,34E-07   1.76E-04     19
1,0071   3,014E+05   1,8494E+05  1,0463E+13   17.6   1.74E-06   7,868E-06   2,969E-04   1,26E-07   1.76E-04     20

CALCULATION IS IN SECTION NO. = 3 AND THE SECTION LENGTH IS =  2.7450 M
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COLLECTION AREA =  2.461E+03 M2          APPLIED VOLTAGE =  4.245E+04 VOLTS           TOTAL CURRENT =  5.560E-01 AMPS
WIRE TO PLATE =  1.397E-01 M             CORONA WIRE RADIUS =  2.095E-03 M            CORONA WIRE LENGTH =  4.795E+03 M
CURRENT/M =  1.164E-04 AMP/M             CURRENT DENSITY =  2.268E-04 AMP/M2          DEPOSIT E FIELD =  1.134E+05 VOLT/M
1/2 WIRE TO WIRE =  9.207E-02 M          GAS FLOW RATE =  1.548E+02 M3/SEC            GAS VELOCITY =  1.251E+00 M/SEC
TEMPERATURE = 430.000 K                  PRESSURE =   1.000 ATM                       VISCOSITY =  2.290E-05 KG/M-SEC
ION MOBILITY =  3.463E-04 M2/VOLT-SEC    MEAN THERMAL SPEED =  5.335E+02 M/SEC        PART. PATH PARAM. =  8.246E-08 M
DUST WEIGHT =  6.969E-01 KG/SEC          LENGTH INCR. = .27450000 M                   INPUT EFF./INCR. = 16.61

ROVRI    ERAVG       EPLT        AFID        CMCD    MMD        WEIGHT      DUST LAYER   J(PART)     J(ION)     INCR. NO.

1.0043   3.039E+05   1.9402E+05  1.3410E+13  22.7    1.68E-06   7.340E-06   2.770E-04    1.24E-07    2.27E-04      21
1.0033   3.039E+05   1.9402E+05  1.3423E+13  22.7    1.61E-06   6.515E-06   2.459E-04    1.15E-07    2.27E-04      22
1.0025   3.039E+05   1.9402E+05  1.3433E+13  22.7    1.55E-06   5.798E-06   2.188E-04    1.08E-07    2.27E-04      23
1.0020   3.039E+05   1.9402E+05  1.3441E+13  22.7    1.50E-06   5.172E-06   1.952E-04    1.01E-07    2.27E-04      24
1.0015   3.039E+05   1.9402E+05  1.3447E+13  22.7    1.45E-06   4.617E-06   1.743E-04    9.41E-08    2.27E-04      25
1.0012   3.039E+05   1.9402E+05  1.3452E+13  22.7    1.40E-06   4.131E-06   1.559E-04    8.79E-08    2.27E-04      26
1.0009   3.039E+05   1.9402E+05  1.3455E+13  22.7    1.36E-06   3.701E-06   1.397E-04    8.19E-08    2.27E-04      27
1.0007   3.039E+05   1.9402E+05  1.3458E+13  22.7    1.32E-06   3.322E-06   1.254E-04    7.64E-08    2.27E-04      28
1.0005   3.039E+05   1.9402E+05  1.3460E+13  22.7    1.28E-06   2.985E-06   1.127E-04    7.12E-08    2.27E-04      29
1.0004   3.039E+05   1.9402E+05  1.3462E+13  22.7    1.24E-06   2.688E-06   1.014E-04    6.64E-08    2.27E-04      30

EST. EFFICIENCY = 99.60      UNCORRECTED COMPUTED EFFICIENCY = 99.39


INCREMENTAL ANALYSIS OF PRECIPITATOR PERFORMANCE


FULL-SCALE,COLD-SIDE ESP:  PLANT A;  SCA=243FT2/1000ACFM; J=15.9UA/FT2

CALCULATION IS IN SECTION NO. = 1 AND THE SECTION LENGTH IS =  2.7450 M

COLLECTION AREA =  2.461E+03 M2          APPLIED VOLTAGE =  4.060E+04 VOLTS           TOTAL CURRENT =  2.730E-01 AMPS
WIRE TO PLATE =  1.397E-01 M             CORONA WIRE RADIUS =  2.095E-03 M            CORONA WIRE LENGTH =  4.795E+03 M
CURRENT/M =  5.694E-05 AMP/M             CURRENT DENSITY =  1.109E-04 AMP/M2          DEPOSIT E FIELD =  5.547E+04 VOLT/M
1/2 WIRE TO WIRE =  9.207E-02 M          GAS FLOW RATE =  1.548E+02 M3/SEC            GAS VELOCITY =  1.251E+00 M/SEC
TEMPERATURE = 430.000 K                  PRESSURE =   1.000 ATM                       VISCOSITY =  2.290E-05 KG/M-SEC
ION MOBILITY =  3.463E-04 M2/VOLT-SEC    MEAN THERMAL SPEED =  5.335E+02 M/SEC        PART. PATH PARAM. =  8.246E-08 M
DUST WEIGHT =  6.969E-01 KG/SEC          LENGTH INCR. = .27450000 M                   INPUT EFF./INCR. = 15.62

ROVRI    ERAVG       EPLT        AFID        CMCD    MMD        WEIGHT      DUST LAYER   J(PART)     J(ION)     INCR. NO.

3.0038   2.906E+05   2.0732E+05  2.2935E+12  11.1    2.29E-05   1.550E-03   5.849E-02    5.06E-07    1.10E-04       1
2.4246   2.906E+05   1.9613E+05  2.8413E+12  11.1    2.26E-05   1.188E-03   4.485E-02    6.31E-07    1.10E-04       2
2.0082   2.906E+05   1.8802E+05  3.4306E+12  11.1    2.22E-05   6.772E-04   2.556E-02    5.21E-07    1.10E-04       3
1.7366   2.906E+05   1.8277E+05  3.9670E+12  11.1    2.13E-05   3.599E-04   1.358E-02    4.12E-07    1.11E-04       4
1.5535   2.906E+05   1.7897E+05  4.4347E+12  11.1    1.90E-05   1.947E-04   7.346E-03    3.40E-07    1.11E-04       5
1.4234   2.906E+05   1.7672E+05  4.8398E+12  11.1    1.19E-05   1.132E-04   4.272E-03    2.97E-07    1.11E-04       6
1.3273   2.906E+05   1.7447E+05  5.1905E+12  11.1    7.44E-06   7.210E-05   2.721E-03    2.67E-07    1.11E-04       7
1.2545   2.906E+05   1.7277E+05  5.4916E+12  11.1    5.11E-06   5.049E-05   1.905E-03    2.46E-07    1.11E-04       8
1.1987   2.906E+05   1.7170E+05  5.7473E+12  11.1    3.90E-06   3.821E-05   1.442E-03    2.28E-07    1.11E-04       9
1.1555   2.906E+05   1.7065E+05  5.9622E+12  11.1    3.20E-06   3.048E-05   1.150E-03    2.13E-07    1.11E-04      10

CALCULATION IS IN SECTION NO. = 2 AND THE SECTION LENGTH IS =  2.7450 M

COLLECTION AREA =  2.461E+03 M2          APPLIED VOLTAGE =  4.210E+04 VOLTS           TOTAL CURRENT =  4.330E-01 AMPS
WIRE TO PLATE =  1.397E-01 M             CORONA WIRE RADIUS =  2.095E-03 M            CORONA WIRE LENGTH =  4.795E+03 M
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CURRENT/M =  9.031E-05 AMP/M             CURRENT DENSITY =  1.760E-04 AMP/M2        DEPOSIT E FIELD =  8.798E+04 VOLT/M
1/2 WIRE TO WIRE =  9.207E-02 M          GAS FLOW RATE =  1.548E+02 M3/SEC          GAS VELOCITY =  1.251E+00 M/SEC
TEMPERATURE = 430.000 K                  PRESSURE =   1.000 ATM                     VISCOSITY =  2.290E-05 KG/M-SEC
ION MOBILITY =  3.463E-04 M2/VOLT-SEC    MEAN THERMAL SPEED =  5.335E+02 M/SEC      PART. PATH PARAM. =  8.246E-08 M
DUST WEIGHT =  6.969E-01 KG/SEC          LENGTH INCR. = .27450000 M                 INPUT EFF./INCR. = 15.62

ROVRI     ERAVG        EPLT        AFID         CMCD     MMD        WEIGHT      DUST LAYER   J(PART)     J(ION)    INCR. NO.

1.0797   3.014E+05  1.8628E+05  9.7597E+12     17.6   2.70E-06    2.781E-05   1.050E-03   2.24E-07    1.70E-04       11
1.0621   3.014E+05  1.8573E+05  9.9217E+12     17.6   2.42E-06    2.335E-05   8.813E-04   2.11E-07    1.70E-04       12
1.0484   3.014E+05  1.8574E+05  1.0051E+13     17.6   2.29E-06    1.992E-05   7.518E-04   1.99E-07    1.70E-04       13
1.0377   3.014E+05  1.8507E+05  1.0154E+13     17.6   2.18E-06    1.710E-05   6.453E-04   1.86E-07    1.70E-04       14
1.0294   3.014E+05  1.8507E+05  1.0236E+13     17.6   2.09E-06    1.484E-05   5.603E-04   1.75E-07    1.70E-04       15
1.0230   3.014E+05  1.8507E+05  1.0301E+13     17.6   2.01E-06    1.296E-05   4.891E-04   1.64E-07    1.70E-04       16
1.0180   3.014E+05  1.8507E+05  1.0351E+13     17.6   1.94E-06    1.137E-05   4.290E-04   1.53E-07    1.70E-04       17
1.0141   3.014E+05  1.8507E+05  1.0391E+13     17.6   1.87E-06    1.001E-05   3.779E-04   1.43E-07    1.70E-04       18
1.0110   3.014E+05  1.8507E+05  1.0423E+13     17.6   1.80E-06    8.850E-06   3.340E-04   1.34E-07    1.70E-04       19
1.0086   3.014E+05  1.8507E+05  1.0447E+13     17.6   1.74E-06    7.845E-06   2.961E-04   1.25E-07    1.70E-04       20

CALCULATION IS IN SECTION NO. = 3 AND THE SECTION LENGTH IS =  2.7450 M

COLLECTION AREA =  2.461E+03 M2          APPLIED VOLTAGE =  4.245E+04 VOLTS          TOTAL CURRENT =  5.580E-01 AMPS
WIRE TO PLATE =  1.397E-01 M             CORONA WIRE RADIUS =  2.095E-03 M           CORONA WIRE LENGTH =  4.795E+03 M
CURRENT/M =  1.164E-04 AMP/M             CURRENT DENSITY =  2.268E-04 AMP/M2         DEPOSIT E FIELD =  1.134E+05 VOLT/M
1/2 WIRE TO WIRE =  9.207E-02 M          GAS FLOW RATE =  1.548E+02 M3/SEC           GAS VELOCITY =  1.251E+00 M/SEC
TEMPERATURE = 430.000 K                  PRESSURE =   1.000 ATM                      VISCOSITY =  2.290E-05 KG/M-SEC
ION MOBILITY =  3.463E-04 M2/VOLT-SEC    MEAN THERMAL SPEED =  5.335E+02 M/SEC       PART. PATH PARAM. =  8.246E-08 M
DUST WEIGHT =  6.969E-01 KG/SEC          LENGTH INCR. = .27450000 M                  INPUT EFF./INCR. = 15.62

ROVRI     ERAVG        EPLT        AFID         CMCD     MMD        WEIGHT      DUST LAYER   J(PART)     J(ION)    INCR. NO.

1.0053   3.039E+05  1.9402E+05  1.3397E+13     22.7   1.67E-06    7.314E-06   2.760E-04   1.23E-07    2.27E-04       21
1.0041   3.039E+05  1.9402E+05  1.3412E+13     22.7   1.61E-06    6.492E-06   2.450E-04   1.15E-07    2.27E-04       22
1.0032   3.039E+05  1.9402E+05  1.3424E+13     22.7   1.55E-06    5.778E-06   2.181E-04   1.08E-07    2.27E-04       23
1.0025   3.039E+05  1.9402E+05  1.3434E+13     22.7   1.50E-06    5.154E-06   1.945E-04   1.01E-07    2.27E-04       24
1.0020   3.039E+05  1.9402E+05  1.3441E+13     22.7   1.45E-06    4.602E-06   1.737E-04   9.39E-08    2.27E-04       25
1.0015   3.039E+05  1.9402E+05  1.3447E+13     22.7   1.40E-06    4.118E-06   1.554E-04   8.77E-08    2.27E-04       26
1.0012   3.039E+05  1.9402E+05  1.3451E+13     22.7   1.36E-06    3.689E-06   1.392E-04   8.17E-08    2.27E-04       27
1.0009   3.039E+05  1.9402E+05  1.3455E+13     22.7   1.32E-06    3.312E-06   1.250E-04   7.62E-08    2.27E-04       28
1.0007   3.039E+05  1.9402E+05  1.3458E+13     22.7   1.28E-06    2.977E-06   1.123E-04   7.11E-08    2.27E-04       29
1.0006   3.039E+05  1.9402E+05  1.3460E+13     22.7   1.24E-06    2.680E-06   1.011E-04   6.62E-08    2.27E-04       30

EST EFFICIENCY = 99.39      COMPUTED EFFICIENCY = 99.39      CONVERGES
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CHARGING RATES FOR PARTICLE SIZES FROM SUBROUTINE CHARGR OR CHGSUM

SRI THEORY USED FOR PARTICLE CHARGING

INCREMENT NO.     Q/QSATF FOR INDICATED PARTICLE SIZES

    0.2000E-06   0.4000E-06   0.7000E-06   0.1100E-05   0.1600E-05   0.2500E-05   0.3500E-05   0.4500E-05
  1  0.5282       0.5200       0.4912       0.4702       0.4571       0.4457       0.4396       0.4361
  2  0.7595       0.7533       0.7134       0.6818       0.6606       0.6415       0.6306       0.6243
  3  0.9197       0.9235       0.8645       0.8157       0.7832       0.7541       0.7378       0.7287
  4  1.0574       1.0680       0.9932       0.9185       0.8699       0.8262       0.8054       0.7931
  5  1.1665       1.1711       1.0841       1.0031       0.9416       0.8833       0.8526       0.8366
  6  1.2556       1.2502       1.1487       1.0591       0.9963       0.9298       0.8889       0.8682
  7  1.3304       1.3141       1.1986       1.1000       1.0329       0.9700       0.9196       0.8931
  8  1.3947       1.3674       1.2391       1.1322       1.0604       0.9969       0.9485       0.9140
  9  1.4507       1.4130       1.2731       1.1586       1.0824       1.0166       0.9732       0.9331
 10  1.5002       1.4527       1.3023       1.1810       1.1007       1.0321       0.9901       0.9521
 11  1.5717       1.5117       1.3476       1.2176       1.1326       1.0616       1.0224       0.9613
 12  1.6312       1.5597       1.3836       1.2460       1.1564       1.0819       1.0418       1.0076
 13  1.6820       1.6001       1.4135       1.2692       1.1755       1.0975       1.0557       1.0239
 14  1.7263       1.6349       1.4389       1.2886       1.1912       1.1100       1.0664       1.0353
 15  1.7655       1.6654       1.4610       1.3054       1.2047       1.1205       1.0752       1.0440
 16  1.8007       1.6926       1.4805       1.3201       1.2164       1.1295       1.0826       1.0511
 17  1.8324       1.7170       1.4980       1.3332       1.2268       1.1374       1.0890       1.0571
 18  1.8614       1.7391       1.5138       1.3450       1.2361       1.1443       1.0947       1.0622
 19  1.8881       1.7594       1.5282       1.3557       1.2445       1.1506       1.0997       1.0622
 20  1.9127       1.7781       1.5414       1.3655       1.2522       1.1563       1.0997       1.0622
 21  1.9421       1.8006       1.5576       1.3777       1.2619       1.1637       1.1064       1.0692
 22  1.9691       1.8211       1.5722       1.3887       1.2706       1.1704       1.1064       1.0692
 23  1.9940       1.8400       1.5857       1.3987       1.2785       1.1763       1.1064       1.0692
 24  2.0170       1.8574       1.5980       1.4079       1.2858       1.1818       1.1064       1.0692
 25  2.0385       1.8736       1.6095       1.4165       1.2924       1.1818       1.1064       1.0692
 26  2.0586       1.8887       1.6201       1.4244       1.2986       1.1818       1.1064       1.0692
 27  2.0775       1.9028       1.6301       1.4317       1.2986       1.1818       1.1064       1.0692
 28  2.0953       1.9162       1.6395       1.4387       1.2986       1.1818       1.1064       1.0692
 29  2.1122       1.9287       1.6483       1.4387       1.2986       1.1818       1.1064       1.0692
 30  2.1282       1.9407       1.6567       1.4387       1.2986       1.1818       1.1064       1.0692

    0.6000E-05   0.8500E-05   0.1250E-04   0.2000E-04   0.2750E-04
  1  0.4329       0.4303       0.4286       0.4278       0.4276
  2  0.6190       0.6153       0.6136       0.6131       0.6130
  3  0.7215       0.7171       0.7155       0.7152       0.7151
  4  0.7840       0.7788       0.7772       0.7769       0.7769
  5  0.8251       0.8188       0.8171       0.8168       0.8168
  6  0.8539       0.8464       0.8443       0.8441       0.8441
  7  0.8753       0.8662       0.8638       0.8635       0.8635
  8  0.8920       0.8810       0.8782       0.8779       0.8779
  9  0.9056       0.8925       0.8892       0.8889       0.8889
 10  0.9173       0.9017       0.8978       0.8974       0.8974
 11  0.9406       0.9244       0.9206       0.9202       0.9202
 12  0.9578       0.9390       0.9348       0.9343       0.9343
 13  0.9724       0.9494       0.9444       0.9439       0.9439
 14  0.9868       0.9573       0.9514       0.9508       0.9508
 15  1.0017       0.9637       0.9567       0.9560       0.9560
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16  1.0121      0.9692      0.9609      0.9601      0.9600
17  1.0196      0.9741      0.9609      0.9601      0.9600
18  1.0256      0.9767      0.9609      0.9601      0.9600
19  1.0306      0.9787      0.9609      0.9601      0.9600
20  1.0306      0.9787      0.9609      0.9601      0.9600
21  1.0374      0.9847      0.9672      0.9663      0.9663
22  1.0374      0.9847      0.9672      0.9663      0.9663
23  1.0374      0.9847      0.9672      0.9663      0.9663
24  1.0374      0.9847      0.9672      0.9663      0.9663
25  1.0374      0.9847      0.9672      0.9663      0.9663
26  1.0374      0.9847      0.9672      0.9663      0.9663
27  1.0374      0.9847      0.9672      0.9663      0.9663
28  1.0374      0.9847      0.9672      0.9663      0.9663
29  1.0374      0.9847      0.9672      0.9663      0.9663
30  1.0374      0.9847      0.9672      0.9663      0.9663
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CHARGE ACCUMULATED ON PARTICLE SIZES IN EACH INCREMENT

INCREMENT        CHARGE FOR INDICATED PARTICLE SIZES

        0.2000E-06    0.4000E-06    0.7000E-06    0.1100E-05    0.1600E-05    0.2500E-05    0.3500E-05    0.4500E-05
  1    0.94105E-18   0.28417E-17   0.75590E-17   0.17365E-16   0.35310E-16   0.83526E-16   0.16107E-15   0.26383E-15
  2    0.13530E-17   0.41169E-17   0.10977E-16   0.25179E-16   0.51036E-16   0.12020E-15   0.23105E-15   0.37773E-15
  3    0.16384E-17   0.50469E-17   0.13304E-16   0.30123E-16   0.60503E-16   0.14130E-15   0.27032E-15   0.44087E-15
  4    0.18838E-17   0.58364E-17   0.15283E-16   0.33918E-16   0.67204E-16   0.15519E-15   0.29510E-15   0.47989E-15
  5    0.20781E-17   0.63998E-17   0.16683E-16   0.37044E-16   0.72737E-16   0.16552E-15   0.31240E-15   0.50617E-15
  6    0.22368E-17   0.68322E-17   0.17677E-16   0.39110E-16   0.76963E-16   0.17423E-15   0.32569E-15   0.52532E-15
  7    0.23701E-17   0.71814E-17   0.18445E-16   0.40621E-16   0.79790E-16   0.18177E-15   0.33695E-15   0.54034E-15
  8    0.24846E-17   0.74730E-17   0.19068E-16   0.41810E-16   0.81917E-16   0.18680E-15   0.34752E-15   0.55301E-15
  9    0.25844E-17   0.77221E-17   0.19591E-16   0.42786E-16   0.83617E-16   0.19049E-15   0.35657E-15   0.56456E-15
 10    0.26725E-17   0.79388E-17   0.20040E-16   0.43612E-16   0.85030E-16   0.19340E-15   0.36277E-15   0.57608E-15
 11    0.27999E-17   0.82613E-17   0.20737E-16   0.44966E-16   0.87493E-16   0.19892E-15   0.37462E-15   0.59372E-15
 12    0.29059E-17   0.85237E-17   0.21292E-16   0.46015E-16   0.89337E-16   0.20274E-15   0.38172E-15   0.60965E-15
 13    0.29964E-17   0.87445E-17   0.21751E-16   0.46869E-16   0.90807E-16   0.20565E-15   0.38680E-15   0.61948E-15
 14    0.30754E-17   0.89346E-17   0.22142E-16   0.47588E-16   0.92026E-16   0.20800E-15   0.39074E-15   0.62638E-15
 15    0.31452E-17   0.91014E-17   0.22483E-16   0.48207E-16   0.93067E-16   0.20996E-15   0.39396E-15   0.63168E-15
 16    0.32078E-17   0.92497E-17   0.22783E-16   0.48751E-16   0.93973E-16   0.21165E-15   0.39668E-15   0.63598E-15
 17    0.32644E-17   0.93831E-17   0.23052E-16   0.49235E-16   0.94774E-16   0.21312E-15   0.39902E-15   0.63959E-15
 18    0.33161E-17   0.95042E-17   0.23295E-16   0.49671E-16   0.95492E-16   0.21443E-15   0.40108E-15   0.64270E-15
 19    0.33635E-17   0.96149E-17   0.23517E-16   0.50066E-16   0.96141E-16   0.21561E-15   0.40292E-15   0.64270E-15
 20    0.34074E-17   0.97169E-17   0.23720E-16   0.50428E-16   0.96734E-16   0.21668E-15   0.40292E-15   0.64270E-15
 21    0.34598E-17   0.98400E-17   0.23969E-16   0.50878E-16   0.97483E-16   0.21807E-15   0.40538E-15   0.64690E-15
 22    0.35079E-17   0.99522E-17   0.24194E-16   0.51284E-16   0.98157E-16   0.21931E-15   0.40538E-15   0.64690E-15
 23    0.35522E-17   0.10055E-16   0.24401E-16   0.51654E-16   0.98768E-16   0.22043E-15   0.40538E-15   0.64690E-15
 24    0.35932E-17   0.10150E-16   0.24591E-16   0.51994E-16   0.99327E-16   0.22144E-15   0.40538E-15   0.64690E-15
 25    0.36315E-17   0.10239E-16   0.24767E-16   0.52308E-16   0.99842E-16   0.22144E-15   0.40538E-15   0.64690E-15
 26    0.36673E-17   0.10321E-16   0.24931E-16   0.52600E-16   0.10032E-15   0.22144E-15   0.40538E-15   0.64690E-15
 27    0.37010E-17   0.10399E-16   0.25085E-16   0.52873E-16   0.10032E-15   0.22144E-15   0.40538E-15   0.64690E-15
 28    0.37327E-17   0.10472E-16   0.25229E-16   0.53129E-16   0.10032E-15   0.22144E-15   0.40538E-15   0.64690E-15
 29    0.37628E-17   0.10540E-16   0.25365E-16   0.53129E-16   0.10032E-15   0.22144E-15   0.40538E-15   0.64690E-15
 30    0.37913E-17   0.10606E-16   0.25494E-16   0.53129E-16   0.10032E-15   0.22144E-15   0.40538E-15   0.64690E-15

        0.6000E-05    0.8500E-05    0.1250E-04    0.2000E-04    0.2750E-04
  1    0.46531E-15   0.92765E-15   0.19978E-14   0.51037E-14   0.96445E-14
  2    0.66536E-15   0.13265E-14   0.28600E-14   0.73140E-14   0.13825E-13
  3    0.77554E-15   0.15461E-14   0.33350E-14   0.85319E-14   0.16128E-13
  4    0.84269E-15   0.16790E-14   0.36224E-14   0.92683E-14   0.17521E-13
  5    0.88685E-15   0.17654E-14   0.38084E-14   0.97446E-14   0.18422E-13
  6    0.91781E-15   0.18247E-14   0.39355E-14   0.10070E-13   0.19037E-13
  7    0.94078E-15   0.18675E-14   0.40263E-14   0.10302E-13   0.19476E-13
  8    0.95870E-15   0.18995E-14   0.40935E-14   0.10474E-13   0.19800E-13
  9    0.97336E-15   0.19243E-14   0.41447E-14   0.10604E-13   0.20047E-13
 10    0.98592E-15   0.19441E-14   0.41848E-14   0.10706E-13   0.20239E-13
 11    0.10109E-14   0.19930E-14   0.42910E-14   0.10978E-13   0.20754E-13
 12    0.10294E-14   0.20245E-14   0.43570E-14   0.11147E-13   0.21072E-13
 13    0.10452E-14   0.20468E-14   0.44019E-14   0.11261E-13   0.21288E-13
 14    0.10606E-14   0.20639E-14   0.44345E-14   0.11343E-13   0.21444E-13
 15    0.10767E-14   0.20778E-14   0.44592E-14   0.11405E-13   0.21561E-13
 16    0.10878E-14   0.20896E-14   0.44787E-14   0.11453E-13   0.21652E-13
 17    0.10959E-14   0.21002E-14   0.44787E-14   0.11453E-13   0.21652E-13
 18    0.11024E-14   0.21101E-14   0.44787E-14   0.11453E-13   0.21652E-13
 19    0.11077E-14   0.21101E-14   0.44787E-14   0.11453E-13   0.21652E-13
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20   0.11077E-14   0.21101E-14   0.44787E-14   0.11453E-13   0.21652E-13
21   0.11150E-14   0.21230E-14   0.45080E-14   0.11527E-13   0.21792E-13
22   0.11150E-14   0.21230E-14   0.45080E-14   0.11527E-13   0.21792E-13
23   0.11150E-14   0.21230E-14   0.45080E-14   0.11527E-13   0.21792E-13
24   0.11150E-14   0.21230E-14   0.45080E-14   0.11527E-13   0.21792E-13
25   0.11150E-14   0.21230E-14   0.45080E-14   0.11527E-13   0.21792E-13
26   0.11150E-14   0.21230E-14   0.45080E-14   0.11527E-13   0.21792E-13
27   0.11150E-14   0.21230E-14   0.45080E-14   0.11527E-13   0.21792E-13
28   0.11150E-14   0.21230E-14   0.45080E-14   0.11527E-13   0.21792E-13
29   0.11150E-14   0.21230E-14   0.45080E-14   0.11527E-13   0.21792E-13
30   0.11150E-14   0.21230E-14   0.45080E-14   0.11527E-13   0.21792E-13
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PARTICLE SIZE RANGE STATISTICS

CORRECTIONS FOR NONIDEALITIES USING SET NO.  1 OF CORRECTION PARAMETERS

   SIZE      CCF  INLET % OUTLET % COR. OUTLET % NO-RAP EFF. NO-RAP W  NO-RAP P  COR. EFF.   COR. W      COR. P
2.000E-07  2.123  0.033   0.7738        0.4724      95.6681      6.582   4.3319   95.4525     6.480      4.5475
4.000E-07  1.530  0.253   8.0107        4.7765      94.1503      5.952   5.8497   94.0028     5.900      5.9972
7.000E-07  1.297  0.903  24.7164       15.0392      94.9431      6.257   5.0569   94.7095     6.163      5.2905
1.100E-06  1.188  0.815  15.8098       10.3816      96.4161      6.979   3.5839   95.9536     6.725      4.0464
1.600E-06  1.130  1.520  19.2419       13.5858      97.6612      7.874   2.3388   97.1606     7.468      2.8392
2.500E-06  1.083  3.524  21.8540       18.1865      98.8543      9.370   1.1457   98.3606     8.619      1.6394
3.500E-06  1.059  1.652   5.4248        6.6540      99.3933     10.703   0.6067   98.7205     9.139      1.2795
4.500E-06  1.046  1.652   3.2106        6.4926      99.6409     11.803   0.3591   98.7516     9.190      1.2464
6.000E-06  1.035  1.982   0.8063        5.9535      99.9246     15.082   0.0752   99.0458     9.754      0.9542
8.500E-06  1.024  3.304   0.1060        6.5293      99.9941     20.408   0.0059   99.3723    10.632      0.6277
1.250E-05  1.017  4.846   0.0026        5.2112      99.9999     32.957   0.0001   99.6584    11.908      0.3416
2.000E-05  1.010 12.115   0.0066        4.2395      99.9999     52.349   0.0001   99.8888    14.262      0.1112
2.750E-05  1.008 67.401   0.0365        2.4778      99.9999     71.773   0.0001   99.9883    18.988      0.0117

EFFICIENCIES FOR CONVERGENCE CHECK:  STATED OR PREVIOUS CALCULATION =  99.387   FINAL CALCULATION =  99.389


     ADJUSTED NO-RAP EFF. =  99.8153
     MMD OF INLET SIZE DISTRIBUTION =  4.465E+01
     SIGMAP OF INLET SIZE DISTRIBUTION =  5.122E+00
     LOG-NORMAL GOODNESS OF FIT =  0.984
     MMD OF EFFLUENT UNDER NO-RAP CONDITIONS =  1.302E+00
     SIGMAP OF EFFLUENT UNDER NO-RAP CONDITIONS =  1.907E+00
     LOG-NORMAL GOODNESS OF FIT =  0.997
     PRECIPITATION RATE PARAMETER UNDER NO-RAP CONDITIONS = 13.196


     SIGMAG=    0.000  WITH  0.000 SNEAKAGE OVER    3.000  STAGES
     NTEMP = 1
     RMMD =  6.00
     RSIGMA = 2.50
     CORR. EFF. =  99.6823
     CORRECTED MMD OF EFFLUENT =  2.670E+00
     CORRECTED SIGMAP OF EFFLUENT =  2.837E+00
     LOG-NORMAL GOODNESS OF FIT =  0.987
     CORRECTED PRECIPITATION RATE PARAMETER =   12.06
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UNADJUSTED MIGRATION VELOCITIES AND EFFICIENCIES, AND DISCRETE OUTLET MASS LOADINGS

IDEAL UNADJUSTED   IDEAL UNADJUSTED    NO-RAP      RAPPING PUFF   NO-RAP+RAP PUFF   RAPPING PUFF   PARTICLE
   MIG. VEL.          EFFICIENCY       DM/DLOGD      DM/DLOGD        DM/DLOGD       DISTRIBUTION     DIAM.
   (CM/SEC)              (%)          (MG/DSCM)     (MG/DSCM)       (MG/DSCM)          (%)           (M)
   2.709E+00          7.252E+01       2.129E-01     1.059E-02       2.235E-01        5.350E-02     2.000E-07
   2.821E+00          7.396E+01       4.740E+00     1.195E-01       4.859E+00        2.606E-01     4.000E-07
   3.382E+00          8.008E+01       1.271E+01     5.871E-01       1.330E+01        1.586E+00     7.000E-07
   4.235E+00          8.673E+01       1.299E+01     1.677E+00       1.467E+01        2.834E+00     1.100E-06
   5.342E+00          9.218E+01       1.533E+01     3.279E+00       1.860E+01        5.720E+00     1.600E-06
   7.378E+00          9.704E+01       1.349E+01     5.813E+00       1.931E+01        1.308E+01     2.500E-06
   9.599E+00          9.897E+01       7.142E+00     7.920E+00       1.506E+01        8.358E+00     3.500E-06
   1.180E+01          9.964E+01       3.617E+00     8.960E+00       1.258E+01        1.105E+01     4.500E-06
   1.508E+01          9.992E+01       8.062E-01     9.429E+00       1.024E+01        1.310E+01     6.000E-06
   2.041E+01          9.999E+01       8.408E-02     8.621E+00       8.905E+00        1.545E+01     8.500E-06
   3.296E+01          1.000E+02       2.042E-03     6.964E+00       6.967E+00        1.245E+01     1.250E-05
   5.235E+01          1.000E+02       3.806E-03     4.225E+00       4.226E+00        1.013E+01     2.000E-05
   7.177E+01          1.000E+02       6.310E-02     7.358E+00       7.421E+00        5.918E+00     2.750E-05
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                                              VISIBLE EMISSION PARAMETERS

                                  LIGHT BEAM PATHLENGTH OR STACK DIAMETER = L =  5.307E+00 METERS
              OUTLET PARTICULATE MASS LOADING = W =  8.318E-03(NO-RAP),  5.987E-03(RAPPING PUFFS), AND  1.431E-02(TOTAL) GM/M**3
            OUTLET PARTICULATE VOLUME LOADING = V =  3.664E-03(NO-RAP),  2.638E-03(RAPPING PUFFS), AND  6.302E-03(TOTAL) CM**3/M**3
                                                  PARTICLE DENSITY = P =  2.270E+00 GM/CM**3

                  COMPOSITION # 1                                                                 COMPOSITION # 2

      NO-RAP          RAPPING PUFFS   NO-RAP+RAP PUFFS          PARTICLE             NO-RAP          RAPPING PUFFS   NO-RAP+RAP PUFFS
   DE/DLOGD(1/M)      DE/DLOGD(1/M)    DE/DLOGD(1/M)            DIAM.(M)          DE/DLOGD(1/M)      DE/DLOGD(1/M)    DE/DLOGD(1/M)
     1.467E-04          7.301E-06        1.540E-04              2.000E-01            2.812E-04          1.399E-05        2.952E-04
     1.073E-02          2.705E-04        1.100E-02              4.000E-01            1.117E-02          2.817E-04        1.145E-02
     3.144E-02          1.452E-03        3.289E-02              7.000E-01            2.553E-02          1.179E-03        2.671E-02
     1.308E-02          1.688E-03        1.477E-02              1.100E+00            1.310E-02          1.690E-03        1.479E-02
     9.123E-03          1.952E-03        1.108E-02              1.600E+00            9.637E-03          2.062E-03        1.170E-02
     4.572E-03          1.970E-03        6.542E-03              2.500E+00            5.237E-03          2.256E-03        7.493E-03
     1.865E-03          2.068E-03        3.933E-03              3.500E+00            1.934E-03          2.144E-03        4.078E-03
     7.691E-04          1.905E-03        2.674E-03              4.500E+00            7.481E-04          1.853E-03        2.601E-03
     1.241E-04          1.451E-03        1.575E-03              6.000E+00            1.229E-04          1.437E-03        1.560E-03
     8.888E-06          9.325E-04        9.414E-04              8.500E+00            8.889E-06          9.325E-04        9.414E-04
     1.439E-07          4.908E-04        4.909E-04              1.250E+01            1.445E-07          4.930E-04        4.932E-04
     1.631E-07          1.811E-04        1.812E-04              2.000E+01            1.660E-07          1.843E-04        1.844E-04
     1.997E-06          2.329E-04        2.349E-04              2.750E+01            1.986E-06          2.316E-04        2.336E-04

 E =  1.533E-02         2.359E-03        1.769E-02----------- M**(-1) ---------- 1.422E-02          2.375E-03        1.660E-02
 SPE= 1.844E+00         3.940E-01        1.237E+00----------- M**2/GM ---------- 1.710E+00          3.966E-01        1.160E+00
 K =  2.390E-01         1.118E+00        3.562E-01---------- CM**3/M**2 -------- 2.577E-01          1.111E+00        3.797E-01

 OP=  7.815E+00         1.244E+00        8.902E+00-------------- % ------------- 7.269E+00          1.252E+00        8.430E+00

  FOR COMPOSITION # 1 REFRACTIVE INDEX =1.50 0.000I,

  FOR COMPOSITION # 2 REFRACTIVE INDEX =1.50-0.100I,

   E  = EXTINCTION COEFFICIENT (M**2/M**3)                                  OP = OPACITY = 1 - EXP(-EL)
  SPE = SPECIFIC MASS EXTINCTION COEFFICIENT (M**2/GM)                          OPACITY = 1 - EXP(-(SPE)WL)
   K  = SPECIFIC PARTICULATE VOLUME (CM**3/M**2)                                OPACITY = 1 - EXP(-WL/PK) = 1 - EXP(-VL/K)

    DE/DLOGD = DIFFERENTIAL EXTINCTION COEFFICIENT (1/M) OR DISTRIBUTION OF OPTICAL EXTINCTION OVER PARTICLE SIZE;
          E = SUMMATION OF (DE/DLOGD)*DLOGD
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                         E.P.A. ESP MODEL
                    I.E.R.L.-R.T.P. AND SO.R.I.

                  SUMMARY TABLE OF ESP OPERATING
                    PARAMETERS AND PERFORMANCE


                        DATA SET NUMBER   1

                  NON-IDEAL CONDITION SET NUMBER  1

ESP PERFORMANCE:     EFFICIENCY =  99.6823 %     SCA =  4.769E+01 M**2/(M**3/SEC)
                                                      ( 242. FT**2/1000 ACFM)

ELECTRICAL CONDITIONS:     AVG. APPLIED VOLTAGE =  4.172E+04 V
                           AVG. CURRENT DENSITY =   17.12 NA/CM**2
                           RESISTIVITY =  5.000E+10 OHM-CM

SIZE DISTRIBUTIONS:     INLET MMD =  4.465E+01 UM     INLET SIGMAP =  5.122E+00
                        OUTLET MMD =  2.670E+00 UM     OUTLET SIGMAP =  2.837E+00

NONIDEAL PARAMETERS:     GAS SNEAKAGE FRACTION =  .00 /SECTION     GAS VELOCITY SIGMAG =  .00
                         RAPPING MMD =  6.000E+00 UM     RAPPING SIGMAP =  2.500E+00

VISIBLE EMISSIONS:   OPACITY =   8.96 %  FOR STACK DIA =  5.31 M  AND E =   0.0177 1/M
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PARTICLE SIZE RANGE STATISTICS

CORRECTIONS FOR NONIDEALITIES USING SET NO.  2 OF CORRECTION PARAMETERS

  SIZE      CCF  INLET % OUTLET % COR. OUTLET % NO-RAP EFF. NO-RAP W  NO-RAP P  COR. EFF.   COR. W     COR. P
2.000E-07  2.123  0.033   0.4600        0.3355     92.3770     5.397    7.6230   91.9851    5.292      8.0149
4.000E-07  1.530  0.253   4.5428        3.2371     90.1809     4.866    9.8191   89.9127    4.810     10.0873
7.000E-07  1.297  0.903  14.9003       10.8219     90.9764     5.043    9.0236   90.5517    4.947      9.4483
1.100E-06  1.188  0.815  10.7615        8.3339     92.7791     5.511    7.2209   91.9383    5.280      8.0617
1.600E-06  1.130  1.520  15.4518       12.4723     94.4409     6.059    5.5591   93.5310    5.741      6.4690
2.500E-06  1.083  3.524  24.2747       20.8496     96.2331     6.875    3.7669   95.3356    6.427      4.6644
3.500E-06  1.059  1.652   8.7288        8.6179     97.1105     7.431    2.8895   95.8873    6.691      4.1127
4.500E-06  1.046  1.652   7.6093        8.6665     97.4811     7.719    2.5189   95.8641    6.679      4.1359
6.000E-06  1.035  1.982   5.1120        7.5638     98.5895     8.935    1.4105   96.9914    7.346      3.0086
8.500E-06  1.024  3.304   4.9151        6.1473     99.1865    10.088    0.8135   98.0559    8.262      1.9441
1.250E-05  1.017  4.846   2.9391        5.8561     99.6683    11.970    0.3317   99.0473    9.757      0.9527
2.000E-05  1.010 12.115   0.2555        3.2829     99.9885    19.013    0.0115   99.7864   12.892      0.2136
2.750E-05  1.008 67.401   0.0491        1.8151     99.9996    71.773    0.0004   99.9788   17.733      0.0212

EFFICIENCIES FOR CONVERGENCE CHECK:  STATED OR PREVIOUS CALCULATION =  99.387   FINAL CALCULATION =  99.389


   ADJUSTED NO-RAP EFF. =  99.4531
   MMD OF INLET SIZE DISTRIBUTION =  4.465E+01
   SIGMAP OF INLET SIZE DISTRIBUTION =  5.122E+00
   LOG-NORMAL GOODNESS OF FIT =  0.984
   MMD OF EFFLUENT UNDER NO-RAP CONDITIONS =  2.068E+00
   SIGMAP OF EFFLUENT UNDER NO-RAP CONDITIONS =  2.269E+00
   LOG-NORMAL GOODNESS OF FIT =  0.997
   PRECIPITATION RATE PARAMETER UNDER NO-RAP CONDITIONS = 10.921


   SIGMAG=    0.250  WITH  0.100 SNEAKAGE OVER    3.000  STAGES
   NTEMP = 1
   RMMD =  6.00
   RSIGMA = 2.50
   CORR. EFF. =  99.2116
   CORRECTED MMD OF EFFLUENT =  2.936E+00
   CORRECTED SIGMAP OF EFFLUENT =  2.617E+00
   LOG-NORMAL GOODNESS OF FIT =  0.995
   CORRECTED PRECIPITATION RATE PARAMETER =   10.15
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UNADJUSTED MIGRATION VELOCITIES AND EFFICIENCIES, AND DISCRETE OUTLET MASS LOADINGS

IDEAL UNADJUSTED   IDEAL UNADJUSTED     NO-RAP      RAPPING PUFF   NO-RAP+RAP PUFF   RAPPING PUFF   PARTICLE
   MIG. VEL.          EFFICIENCY       DM/DLOGD       DM/DLOGD        DM/DLOGD       DISTRIBUTION     DIAM.
   (CM/SEC)              (%)          (MG/DSCM)      (MG/DSCM)       (MG/DSCM)           (%)           (M)
   2.709E+00          7.252E+01       3.746E-01      1.926E-02       3.939E-01        5.350E-02     2.000E-07
   2.821E+00          7.396E+01       7.956E+00      2.173E-01       8.173E+00        2.606E-01     4.000E-07
   3.382E+00          8.008E+01       2.268E+01      1.067E+00       2.375E+01        1.586E+00     7.000E-07
   4.235E+00          8.673E+01       2.618E+01      3.049E+00       2.923E+01        2.634E+00     1.100E-06
   5.342E+00          9.218E+01       3.643E+01      5.962E+00       4.239E+01        5.720E+00     1.600E-06
   7.378E+00          9.704E+01       4.436E+01      1.057E+01       5.493E+01        1.308E+01     2.500E-06
   9.599E+00          9.897E+01       3.402E+01      1.440E+01       4.842E+01        8.358E+00     3.500E-06
   1.180E+01          9.964E+01       2.538E+01      1.629E+01       4.167E+01        1.105E+01     4.500E-06
   1.508E+01          9.992E+01       1.513E+01      1.714E+01       3.227E+01        1.310E+01     6.000E-06
   2.041E+01          9.999E+01       1.154E+01      1.604E+01       2.758E+01        1.545E+01     8.500E-06
   3.296E+01          1.000E+02       6.762E+00      1.266E+01       1.942E+01        1.245E+01     1.250E-05
   5.235E+01          1.000E+02       4.382E-01      7.681E+00       8.119E+00        1.013E+01     2.000E-05
   7.177E+01          1.000E+02       2.512E-01      1.338E+01       1.363E+01        5.918E+00     2.750E-05
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                                                   VISIBLE EMISSION PARAMETERS

                                         LIGHT BEAM PATHLENGTH OR STACK DIAMETER = L =  5.307E+00 METERS
              OUTLET PARTICULATE MASS LOADING = W =  2.462E-02(NO-RAP),  1.069E-02(RAPPING PUFFS), AND  3.551E-02(TOTAL) GM/M**3
            OUTLET PARTICULATE VOLUME LOADING = V =  1.085E-02(NO-RAP),  4.796E-03(RAPPING PUFFS), AND  1.564E-02(TOTAL) CM**3/M**3
                                                  PARTICLE DENSITY = P =  2.270E+00 GM/CM**3

                       COMPOSITION # 1                                                            COMPOSITION # 2

       NO-RAP          RAPPING PUFFS   NO-RAP+RAP PUFFS          PARTICLE            NO-RAP          RAPPING PUFFS   NO-RAP+RAP PUFFS
    DE/DLOGD(1/M)      DE/DLOGD(1/M)     DE/DLOGD(1/M)           DIAM.(M)         DE/DLOGD(1/M)      DE/DLOGD(1/M)     DE/DLOGD(1/M)
     2.581E-04          1.327E-05         2.714E-04             2.000E-01          4.948E-04          2.544E-05         5.202E-04
     1.801E-02          4.918E-04         1.850E-02             4.000E-01          1.875E-02          5.122E-04         1.927E-02
     5.610E-02          2.641E-03         5.875E-02             7.000E-01          4.555E-02          2.144E-03         4.769E-02
     2.635E-02          3.068E-03         2.942E-02             1.100E+00          2.639E-02          3.073E-03         2.946E-02
     2.169E-02          3.549E-03         2.523E-02             1.600E+00          2.291E-02          3.749E-03         2.665E-02
     1.503E-02          3.582E-03         1.861E-02             2.500E+00          1.722E-02          4.102E-03         2.132E-02
     8.883E-03          3.761E-03         1.264E-02             3.500E+00          9.209E-03          3.899E-03         1.311E-02
     5.396E-03          3.464E-03         8.860E-03             4.500E+00          5.248E-03          3.369E-03         8.617E-03
     2.328E-03          2.638E-03         4.966E-03             6.000E+00          2.306E-03          2.612E-03         4.918E-03
     1.220E-03          1.695E-03         2.915E-03             8.500E+00          1.220E-03          1.695E-03         2.916E-03
     4.765E-04          8.923E-04         1.369E-03             1.250E+01          4.787E-04          8.964E-04         1.375E-03
     1.878E-05          3.292E-04         3.480E-04             2.000E+01          1.911E-05          3.350E-04         3.541E-04
     7.950E-06          4.234E-04         4.314E-04             2.750E+01          7.908E-06          4.212E-04         4.291E-04

E =  3.153E-02          4.289E-03         3.581E-02------------ M**(-1) ----------- 2.979E-02          4.318E-03         3.411E-02
SPE= 1.280E+00          3.940E-01         1.009E+00------------ M**2/GM ----------- 1.210E+00          3.966E-01         9.608E-01
K =  3.440E-01          1.118E+00         4.367E-01----------- CM**3/M**2 --------- 3.640E-01          1.111E+00         4.585E-01

OP=  1.541E+01          2.250E+00         1.731E+01--------------- % -------------- 1.463E+01          2.265E+00         1.656E+01

 FOR COMPOSITION # 1 REFRACTIVE INDEX =1.50 0.000I,

 FOR COMPOSITION # 2 REFRACTIVE INDEX =1.50-0.100I,

  E  = EXTINCTION COEFFICIENT (M**2/M**3)                                     OP = OPACITY = 1 - EXP(-EL)
 SPE = SPECIFIC MASS EXTINCTION COEFFICIENT (M**2/GM)                              OPACITY = 1 - EXP(-(SPE)WL)
  K  = SPECIFIC PARTICULATE VOLUME (CM**3/M**2)                                    OPACITY = 1 - EXP(-WL/PK) = 1 - EXP(-VL/K)

   DE/DLOGD = DIFFERENTIAL EXTINCTION COEFFICIENT (1/M) OR DISTRIBUTION OF OPTICAL EXTINCTION OVER PARTICLE SIZE;
         E = SUMMATION OF (DE/DLOGD)*DLOGD
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*****************************************************************************************
*                                                                                       *
*                               E.P.A. ESP MODEL                                        *
*                         I.E.R.L.-R.T.P. AND SO.R.I.                                   *
*                                                                                       *
*                       SUMMARY TABLE OF ESP OPERATING                                  *
*                         PARAMETERS AND PERFORMANCE                                    *
*                                                                                       *
*                                                                                       *
*                              DATA SET NUMBER   1                                      *
*                                                                                       *
*                       NON-IDEAL CONDITION SET NUMBER  2                               *
*                                                                                       *
*  ESP PERFORMANCE:     EFFICIENCY =  99.2116 %     SCA =  4.769E+01 M**2/(M**3/SEC)    *
*                                                          ( 242. FT**2/1000 ACFM)      *
*                                                                                       *
*  ELECTRICAL CONDITIONS:     AVG. APPLIED VOLTAGE =  4.172E+04 V                       *
*                             AVG. CURRENT DENSITY =   17.12 NA/CM**2                   *
*                             RESISTIVITY =  5.000E+10 OHM-CM                           *
*                                                                                       *
*  SIZE DISTRIBUTIONS:     INLET MMD =  4.465E+01 UM     INLET SIGMAP =  5.122E+00      *
*                          OUTLET MMD =  2.936E+00 UM     OUTLET SIGMAP =  2.617E+00    *
*                                                                                       *
*  NONIDEAL PARAMETERS:     GAS SNEAKAGE FRACTION =  .10 /SECTION     GAS VELOCITY SIGMAG =  .25
*                           RAPPING MMD =  6.000E+00 UM     RAPPING SIGMAP =  2.500E+00 *
*                                                                                       *
*  VISIBLE EMISSIONS:   OPACITY =  17.31 %  FOR STACK DIA =  5.31 M  AND E =   0.0358 1/M
*                                                                                       *
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APPENDIX D

OUTPUT DATA FROM EXAMPLE 4

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*************************************
*                                   *
*         E.P.A. ESP MODEL          *
*                                   *
*   I.E.R.L.-R.T.P. AND SO.R.I.     *
*                                   *
*           REVISION III            *
*                                   *
*************************************

PRINTOUT OF INPUT DATA FOR DATA SET NUMBER  1


DATA ON CARD NUMBER   1

NENDPT = 15   NDATA =  1   NRAP =  0   MODL =  0   NOPRNT =  0   PATHL =  0.00 FT   NCOMPS =  0   NWAVES =  0  NLAMDA =  0

DATA ON CARD NUMBER   2

FULL-SCALE,HOT-SIDE ESP: PLANT B;SCA=390FT2/1000ACFM;J=34.3UA/FT2

DATA ON CARD NUMBER   3

NEST =  1  NDIST =  1  NVI =  1  NX = 10  NY = 10  NITER =  3  NCALC =  0  NRAPD =  1  NEFF =  1  NTEMP =  2  NUMID =  2

DATA ON CARD NUMBER   4

NN =  5

DATA ON CARD NUMBER   5

DL =  2.51000 GRN/ACF  PL =  36.0000 FT  ETAU = 99.60000 %  DD =  2270.00 KG/M**3  EPS =  1.000E+02
VRATIO =   1.2000  US =  .000220 M**2/V-SEC  FPATH =   1.0000  EBD = 1500000. V/M  RHOCGS =  1.90E+10 OHM-CM

DATA ON CARD NUMBER   6

ASNUCK( 1) =  .00  AZIGGY( 1) =  .00  AZNUMS( 1) =  4.0
ASNUCK( 2) =  .10  AZIGGY( 2) =  .25  AZNUMS( 2) =  4.0


DATA ON CARD NUMBER   7
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ENDPT( 1) =    0.200 UM   ENDPT( 2) =    0.400 UM   ENDPT( 3) =    0.700 UM   ENDPT( 4) =    1.000 UM   ENDPT( 5) =    1.500 UM
ENDPT( 6) =    2.000 UM   ENDPT( 7) =    3.000 UM   ENDPT( 8) =    4.000 UM   ENDPT( 9) =    5.000 UM   ENDPT(10) =    7.000 UM


DATA ON CARD NUMBER   8

ENDPT(11) =   10.000 UM   ENDPT(12) =   15.000 UM   ENDPT(13) =   25.000 UM   ENDPT(14) =   30.000 UM   ENDPT(15) =  100.000 UM


DATA ON CARD NUMBER   9

PRCU( 1) =   0.0000 %   PRCU( 2) =   0.1479 %   PRCU( 3) =   0.5742 %   PRCU( 4) =   1.0092 %   PRCU( 5) =   1.7226 %
PRCU( 6) =   2.7493 %   PRCU( 7) =   6.5251 %   PRCU( 8) =   9.4832 %   PRCU( 9) =  11.1363 %   PRCU(10) =  13.0503 %


DATA ON CARD NUMBER  10

PRCU(11) =  15.6256 %   PRCU(12) =  20.1844 %   PRCU(13) =  30.9727 %   PRCU(14) =  35.4968 %   PRCU(15) = 100.0000 %


DATA ON CARD NUMBER  11

NUMSEC =  4    LSECT( 1) =  9  LSECT( 2) =  9  LSECT( 3) =  9  LSECT( 4) =  9

DATA ON CARD NUMBER  12

AS( 1) =  4.2120E+04 FT**2  VOS( 1) =  3.5880E+04 V  ICS( 1) =  1.2200E+00 A  WLS( 1) =  5.6160E+04 FT
ACS( 1) =  5.4500E-02 IN  BS( 1) =  4.5000E+00 IN  NWS( 1) =  1.2000E+01

DATA ON CARD NUMBER  13

SYS( 1) =  4.5000E+00 IN  VGS( 1) =  4.3207E+05 FT**3/MIN  VGASS( 1) =  3.7958E+00 FT/SEC  TEMPS( 1) =  6.2400E+02 F
PS( 1) =  1.0000E+00 ATM  VISS( 1) =  2.8000E-05 KG/M-SEC  LINCS( 1) =  1.0000E+00 FT

DATA ON CARD NUMBER  14

AS( 2) =  4.2120E+04 FT**2  VOS( 2) =  3.3950E+04 V  ICS( 2) =  1.6720E+00 A  WLS( 2) =  5.6160E+04 FT
ACS( 2) =  5.4500E-02 IN  BS( 2) =  4.5000E+00 IN  NWS( 2) =  1.2000E+01
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DATA ON CARD NUMBER  15

SYS( 2) =  4.5000E+00 IN  VGS( 2) =  4.3207E+05 FT**3/MIN  VGASS( 2) =  3.7958E+00 FT/SEC  TEMPS( 2) =  6.2400E+02 F

PS( 2) =  1.0000E+00 ATM  VISS( 2) =  2.8000E-05 KG/M-SEC  LINCS( 2) =  1.0000E+00 FT

DATA ON CARD NUMBER  16

AS( 3) =  4.2120E+04 FT**2  VOS( 3) =  2.9130E+04 V  TCS( 3) =  1.4200E+00 A  WLS( 3) =  5.6160E+04 FT

ACS( 3) =  5.4500E-02 IN  BS( 3) =  4.5000E+00 IN  NWS( 3) =  1.2000E+01

DATA ON CARD NUMBER  17

SYS( 3) =  4.5000E+00 IN  VGS( 3) =  4.3207E+05 FT**3/MIN  VGASS( 3) =  3.7958E+00 FT/SEC  TEMPS( 3) =  6.2400E+02 F

PS( 3) =  1.0000E+00 ATM  VISS( 3) =  2.8000E-05 KG/M-SEC  LINCS( 3) =  1.0000E+00 FT

DATA ON CARD NUMBER  18

AS( 4) =  4.2120E+04 FT**2  VOS( 4) =  2.7500E+04 V  TCS( 4) =  1.4600E+00 A  WLS( 4) =  5.6160E+04 FT

ACS( 4) =  5.4500E-02 IN  BS( 4) =  4.5000E+00 IN  NWS( 4) =  1.2000E+01

DATA ON CARD NUMBER  19

SYS( 4) =  4.5000E+00 IN  VGS( 4) =  4.3207E+05 FT**3/MIN  VGASS( 4) =  3.7958E+00 FT/SEC  TEMPS( 4) =  6.2400E+02 F

PS( 4) =  1.0000E+00 ATM  VISS( 4) =  2.8000E-05 KG/M-SEC  LINCS( 4) =  1.0000E+00 FT
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INCREMENTAL ANALYSIS OF PRECIPITATOR PERFORMANCE


FULL-SCALE,HOT-SIDE ESP: PLANT H;SCA=390FT2/1000ACFM;J=34,30A/FT2

CALCULATION IS IN SECTION NO, = 1 AND THE SECTION LENGTH IS =  2,7450 M

COLLECTION AREA =  3,917E+03 M2          APPLIED VOLTAGE =  3,588E+04 VOLTS          TOTAL CURRENT =  1,220E+00 AMPS
WIRE TO PLATE =  1,143E-01 M             CORONA WIRE RADIUS =  1,384E-03 M           CORONA WIRE LENGTH =  1,713E+04 M
CURRENT/M =  7,123E-05 AMP/M             CURRENT DENSITY =  3.115E-04 AMP/M2         DEPOSIT E FIELD =  5,918E+04 VOLT/M
1/2 WIRE TO WIRE =  1,143E-01 M          GAS FLOW RATE =  2,044E+02 M3/SEC           GAS VELOCITY =  1,158E+00 M/SEC
TEMPERATURE = 601,667 K                  PRESSURE =   1,000 ATM                      VISCOSITY =  2,800E-05 KG/M-SEC
ION MOBILITY =  4,846E-04 M2/VOLT-SEC    MEAN THERMAL SPEED =  6,311E+02 M/SEC       PART, PATH PARAM, =  1,154E-07 M
DUST WEIGHT =  1,175E+00 KG/SEC          LENGTH INCR, = ,30500000 M                  INPUT EFF,/INCR, = 14,22

ROVRI     ERAVG       EPLT        AFID        CMCD      MMD        WEIGHT     DUST LAYER   J(PART)      J(ION)   INCR, NO,

1,5597   3,139E+05  1,8151E+05  8,2047E+12    31,1    4,22E-05   4,134E-03   1,165E-01   1,26E-06    3,10E-04       1
1,3631   3,139E+05  1,7449E+05  9,3879E+12    31,1    2,04E-05   6,980E-04   1,967E-02   7,06E-07    3,11E-04       2
1,2645   3,139E+05  1,7124E+05  1,0120E+13    31,1    1,11E-05   2,549E-04   7,180E-03   5,58E-07    3,11E-04       3
1,1978   3,139E+05  1,6891E+05  1,0684E+13    31,1    6,92E-06   1,472E-04   4,147E-03   4,77E-07    3,11E-04       4
1,1495   3,139E+05  1,6700E+05  1,1132E+13    31,1    4,69E-06   9,909E-05   2,792E-03   4,18E-07    3,11E-04       5
1,1138   3,139E+05  1,6559E+05  1,1489E+13    31,1    3,61E-06   7,208E-05   2,031E-03   3,72E-07    3,11E-04       6
1,0871   3,139E+05  1,6454E+05  1,1772E+13    31,1    3,16E-06   5,512E-05   1,553E-03   3,33E-07    3,11E-04       7
1,0668   3,139E+05  1,6379E+05  1,1995E+13    31,1    2,86E-06   4,365E-05   1,230E-03   3,00E-07    3,11E-04       8
1,0514   3,139E+05  1,6379E+05  1,2171E+13    31,1    2,63E-06   3,552E-05   1,001E-03   2,72E-07    3,11E-04       9

CALCULATION IS IN SECTION NO, = 2 AND THE SECTION LENGTH IS =  2,7450 M

COLLECTION AREA =  3,917E+03 M2          APPLIED VOLTAGE =  3,395E+04 VOLTS          TOTAL CURRENT =  1,672E+00 AMPS
WIRE TO PLATE =  1,143E-01 M             CORONA WIRE RADIUS =  1,384E-03 M           CORONA WIRE LENGTH =  1,713E+04 M
CURRENT/M =  9,761E-05 AMP/M             CURRENT DENSITY =  4,268E-04 AMP/M2         DEPOSIT E FIELD =  8,110E+04 VOLT/M
1/2 WIRE TO WIRE =  1,143E-01 M          GAS FLOW RATE =  2,044E+02 M3/SEC           GAS VELOCITY =  1,158E+00 M/SEC
TEMPERATURE = 601,667 K                  PRESSURE =   1,000 ATM                      VISCOSITY =  2,800E-05 KG/M-SEC
ION MOBILITY =  4,846E-04 M2/VOLT-SEC    MEAN THERMAL SPEED =  6,311E+02 M/SEC       PART, PATH PARAM, =  1,154E-07 M
DUST WEIGHT =  1,175E+00 KG/SEC          LENGTH INCR, = ,30500000 M                  INPUT EFF,/INCR, = 14,22

ROVRI     ERAVG       EPLT        AFID        CMCD      MMD        WEIGHT     DUST LAYER   J(PART)      J(ION)   INCR, NO,

1,0274   2,970E+05  1,7199E+05  1,8041E+13    42,7    2,46E-06   3,064E-05   8,632E-04   2,59E-07    4,27E-04      10
1,0210   2,970E+05  1,7199E+05  1,8154E+13    42,7    2,37E-06   2,535E-05   7,141E-04   2,34E-07    4,27E-04      11
1,0161   2,970E+05  1,7199E+05  1,8240E+13    42,7    2,30E-06   2,118E-05   5,968E-04   2,12E-07    4,27E-04      12
1,0124   2,970E+05  1,7199E+05  1,8307E+13    42,7    2,23E-06   1,785E-05   5,029E-04   1,92E-07    4,27E-04      13
1,0096   2,970E+05  1,7199E+05  1,8359E+13    42,7    2,18E-06   1,511E-05   4,258E-04   1,74E-07    4,27E-04      14
1,0074   2,970E+05  1,7199E+05  1,8399E+13    42,7    2,12E-06   1,287E-05   3,625E-04   1,56E-07    4,27E-04      15
1,0057   2,970E+05  1,7199E+05  1,8430E+13    42,7    2,07E-06   1,100E-05   3,100E-04   1,43E-07    4,27E-04      16
1,0044   2,970E+05  1,7199E+05  1,8454E+13    42,7    2,03E-06   9,442E-06   2,660E-04   1,30E-07    4,27E-04      17
1,0034   2,970E+05  1,7199E+05  1,8472E+13    42,7    1,98E-06   8,130E-06   2,291E-04   1,18E-07    4,27E-04      18

CALCULATION IS IN SECTION NO, = 3 AND THE SECTION LENGTH IS =  2,7450 M

COLLECTION AREA =  3,917E+03 M2          APPLIED VOLTAGE =  2,913E+04 VOLTS          TOTAL CURRENT =  1,420E+00 AMPS
WIRE TO PLATE =  1,143E-01 M             CORONA WIRE RADIUS =  1,384E-03 M           CORONA WIRE LENGTH =  1,713E+04 M
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CURRENT/M =  8.290E-05 AMP/M             CURRENT DENSITY =  3.625E-04 AMP/M2       DEPOSIT E FIELD =  6.888E+04 VOLT/M
1/2 WIRE TO WIRE =  1.143E-01 M          GAS FLOW RATE =  2.044E+02 M3/SEC         GAS VELOCITY =  1.158E+00 M/SEC
TEMPERATURE = 601.667 K                  PRESSURE =   1.000 ATM                    VISCOSITY =  2.800E-05 KG/M-SEC
ION MOBILITY =  4.846E-04 M2/VOLT-SEC    MEAN THERMAL SPEED =  6.311E+02 M/SEC     PART. PATH PARAM. =  1.154E-07 M
DUST WEIGHT =  1.175E+00 KG/SEC          LENGTH INCR. = .30500000 M                INPUT EFF./INCR. = 14.22

ROVRI     ERAVG       EPLT        AFID        CMCD     MMD        WEIGHT      DUST LAYER  J(PART)     J(ION)    INCR. NO.

1,0027   2,549E+05  1,5281E+05  1,8297E+13   36,3   1,94E-06   6,284E-06   1,770E-04   9,57E-08   3,62E-04     19
1,0021   2,549E+05  1,5281E+05  1,8308E+13   36,3   1,91E-06   5,521E-06   1,556E-04   8,75E-08   3,62E-04     20
1,0016   2,549E+05  1,5281E+05  1,8316E+13   36,3   1,87E-06   4,862E-06   1,370E-04   8,00E-08   3,62E-04     21
1,0013   2,549E+05  1,5281E+05  1,8323E+13   36,3   1,83E-06   4,289E-06   1,208E-04   7,32E-08   3,62E-04     22
1,0010   2,549E+05  1,5281E+05  1,8328E+13   36,3   1,80E-06   3,791E-06   1,068E-04   6,71E-08   3,62E-04     23
1,0008   2,549E+05  1,5281E+05  1,8332E+13   36,3   1,76E-06   3,356E-06   9,455E-05   6,15E-08   3,62E-04     24
1,0006   2,549E+05  1,5281E+05  1,8335E+13   36,3   1,71E-06   2,976E-06   8,384E-05   5,64E-08   3,62E-04     25
1,0005   2,549E+05  1,5281E+05  1,8337E+13   36,3   1,66E-06   2,642E-06   7,444E-05   5,16E-08   3,62E-04     26
1,0004   2,549E+05  1,5281E+05  1,8339E+13   36,3   1,60E-06   2,350E-06   6,620E-05   4,73E-08   3,62E-04     27
CALCULATION IS IN SECTION NO. = 4 AND THE SECTION LENGTH IS =  2,7450 M

COLLECTION AREA =  3,917E+03 M2          APPLIED VOLTAGE =  2.750E+04 VOLTS          TOTAL CURRENT =  1,460E+00 AMPS
WIRE TO PLATE =  1,143E-01 M             CORONA WIRE RADIUS =  1,384E-03 M           CORONA WIRE LENGTH =  1.713E+04 M
CURRENT/M =  8,524E-05 AMP/M             CURRENT DENSITY =  3.727E-04 AMP/M2         DEPOSIT E FIELD =  7,082E+04 VOLT/M
1/2 WIRE TO WIRE =  1,143E-01 M          GAS FLOW RATE =  2,044E+02 M3/SEC           GAS VELOCITY =  1.158E+00 M/SEC
TEMPERATURE = 601.667 K                  PRESSURE =   1,000 ATM                      VISCOSITY =  2,800E-05 KG/M-SEC
ION MOBILITY =  4,846E-04 M2/VOLT-SEC    MEAN THERMAL SPEED =  6,311E+02 M/SEC       PART. PATH PARAM. =  1.154E-07 M
DUST WEIGHT =  1,175E+00 KG/SEC          LENGTH INCR. = ,30500000 M                  INPUT EFF./INCR. = 14,22

ROVRI     ERAVG       EPLT        AFID        CMCD     MMD        WEIGHT      DUST LAYER  J(PART)     J(ION)    INCR. NO.

1,0003   2,406E+05  1,5104E+05  1,9975E+13   37,3   1,55E-06   2,069E-06   5,830E-05   4,28E-08   3,73E-04     28
1,0002   2,406E+05  1,5104E+05  1,9976E+13   37,3   1,50E-06   1,848E-06   5,205E-05   3,93E-08   3,73E-04     29
1,0002   2,406E+05  1,5104E+05  1,9977E+13   37,3   1,46E-06   1,652E-06   4,653E-05   3,61E-08   3,73E-04     30
1,0001   2,406E+05  1,5104E+05  1,9978E+13   37,3   1,41E-06   1,478E-06   4,164E-05   3,32E-08   3,73E-04     31
1,0001   2,406E+05  1,5104E+05  1,9979E+13   37,3   1,36E-06   1,324E-06   3,731E-05   3,05E-08   3,73E-04     32
1,0001   2,406E+05  1,5104E+05  1,9979E+13   37,3   1,32E-06   1,188E-06   3,347E-05   2,80E-08   3,73E-04     33
1,0001   2,406E+05  1,5104E+05  1,9979E+13   37,3   1,27E-06   1,067E-06   3,006E-05   2,58E-08   3,73E-04     34
1,0001   2,406E+05  1,5104E+05  1,9980E+13   37,3   1,23E-06   9,590E-07   2,702E-05   2,37E-08   3,73E-04     35
1,0000   2,406E+05  1,5104E+05  1,9980E+13   37,3   1,20E-06   8,630E-07   2,431E-05   2,19E-08   3,73E-04     36
EST. EFFICIENCY = 99,60      UNCORRECTED COMPUTED EFFICIENCY = 99,85


INCREMENTAL ANALYSIS OF PRECIPITATOR PERFORMANCE



FULL-SCALE,HOT-SIDE ESP: PLANT B;SCA=390FT2/1000ACFM;J=34.30A/FT2


CALCULATION IS IN SECTION NO. = 1 AND THE SECTION LENGTH IS =  2,7450 M

COLLECTION AREA =  3,917E+03 M2          APPLIED VOLTAGE =  3.588E+04 VOLTS          TOTAL CURRENT =  1,220E+00 AMPS
WIRE TO PLATE =  1.143E-01 M             CORONA WIRE RADIUS =  1.384E-03 M           CORONA WIRE LENGTH =  1.713E+04 M
CURRENT/M =  7.123E-05 AMP/M             CURRENT DENSITY =  3.115E-04 AMP/M2         DEPOSIT E FIELD =  5.918E+04 VOLT/M
1/2 WIRE TO WIRE =  1.143E-01 M          GAS FLOW RATE =  2,044E+02 M3/SEC           GAS VELOCITY =  1.158E+00 M/SEC
TEMPERATURE = 601.667 K                  PRESSURE =   1,000 ATM                      VISCOSITY =  2,800E-05 KG/M-SEC
ION MOBILITY =  4,846E-04 M2/VOLT-SEC    MEAN THERMAL SPEED =  6.311E+02 M/SEC       PART. PATH PARAM. =  1.154E-07 M
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DUST WEIGHT =  1.175E+00 KG/SEC        LENGTH INCR. = .30500000 M             INPUT EFF./INCR. = 16.57

ROVRI     ERAVG        EPLT         AFID        CMCD      MMD        WEIGHT      DUST LAYER   J(PART)      J(ION)    INCR. NO.

1,6520   3,139E+05  1,8428E+05  7,7461E+12     31,1   4,21E-05   4,137E-03   1,166E-01   1,27E-06   3,10E-04       1
1,4113   3,139E+05  1,7617E+05  9,0672E+12     31,1   2,03E-05   6,965E-04   1,962E-02   7,02E-07   3,11E-04       2
1,2913   3,139E+05  1,7218E+05  9,9097E+12     31,1   1,11E-05   2,539E-04   7,154E-03   5,55E-07   3,11E-04       3
1,2119   3,139E+05  1,6936E+05  1,0559E+13     31,1   6,88E-06   1,466E-04   4,130E-03   4,75E-07   3,11E-04       4
1,1559   3,139E+05  1,6699E+05  1,1071E+13     31,1   4,67E-06   9,864E-05   2,779E-03   4,16E-07   3,11E-04       5
1,1155   3,139E+05  1,6558E+05  1,1472E+13     31,1   3,60E-06   7,187E-05   2,025E-03   3,70E-07   3,11E-04       6
1,0859   3,139E+05  1,6453E+05  1,1784E+13     31,1   3,16E-06   5,503E-05   1,550E-03   3,32E-07   3,11E-04       7
1,0641   3,139E+05  1,6379E+05  1,2025E+13     31,1   2,86E-06   4,362E-05   1,229E-03   2,99E-07   3,11E-04       8
1,0480   3,139E+05  1,6304E+05  1,2211E+13     31,1   2,63E-06   3,537E-05   9,964E-04   2,70E-07   3,11E-04       9

CALCULATION IS IN SECTION NO. = 2 AND THE SECTION LENGTH IS =  2,7450 M

COLLECTION AREA =  3,917E+03 M2          APPLIED VOLTAGE =  3,395E+04 VOLTS       TOTAL CURRENT =  1,672E+00 AMPS
WIRE TO PLATE =  1.143E-01 M             CORONA WIRE RADIUS =  1.384E-03 M        CORONA WIRE LENGTH =  1.713E+04 M
CURRENT/M =  9.761E-05 AMP/M             CURRENT DENSITY =  4.268E-04 AMP/M2      DEPOSIT E FIELD =  8.110E+04 VOLT/M
1/2 WIRE TO WIRE =  1.143E-01 M          GAS FLOW RATE =  2.044E+02 M3/SEC        GAS VELOCITY =  1.158E+00 M/SEC
TEMPERATURE = 601,667 K                  PRESSURE =    1,000 ATM                  VISCOSITY =  2,800E-05 KG/M-SEC
ION MOBILITY =  4,846E-04 M2/VOLT-SEC  MEAN THERMAL SPEED =  6.311E+02 M/SEC     PART. PATH PARAM. =  1.154E-07 M
DUST WEIGHT =  1.175E+00 KG/SEC          LENGTH INCR. = .30500000 M               INPUT EFF./INCR. = 16,57

ROVRI     ERAVG        EPLT         AFID        CMCD      MMD        WEIGHT      DUST LAYER   J(PART)      J(ION)    INCR. NO.

1,0249   2,970E+05  1.7200E+05  1,8085E+13     42,7   2,46E-06   3,067E-05   8,642E-04   2,59E-07   4,27E-04      10
1,0186   2,970E+05  1.7200E+05  1,8197E+13     42,7   2,37E-06   2,538E-05   7,150E-04   2,34E-07   4,27E-04      11
1,0139   2,970E+05  1.7200E+05  1,8281E+13     42,7   2,30E-06   2.122E-05   5,977E-04   2,12E-07   4,27E-04      12
1,0104   2,970E+05  1.7200E+05  1,8344E+13     42,7   2,23E-06   1,788E-05   5,037E-04   1,92E-07   4,27E-04      13
1,0076   2,970E+05  1.7200E+05  1,8392E+13     42,7   2,18E-06   1,514E-05   4,265E-04   1,74E-07   4,27E-04      14
1,0058   2,970E+05  1.7200E+05  1,8427E+13     42,7   2,12E-06   1,289E-05   3,632E-04   1,56E-07   4,27E-04      15
1,0044   2,970E+05  1.7200E+05  1,8454E+13     42,7   2,07E-06   1,102E-05   3,106E-04   1,43E-07   4,27E-04      16
1,0033   2,970E+05  1.7200E+05  1,8474E+13     42,7   2,03E-06   9,466E-06   2,667E-04   1,30E-07   4,27E-04      17
1,0025   2,970E+05  1.7200E+05  1,8489E+13     42,7   1,98E-06   8,151E-06   2.296E-04   1,18E-07   4,27E-04      18

CALCULATION IS IN SECTION NO. = 3 AND THE SECTION LENGTH IS =  2,7450 M

COLLECTION AREA =  3,917E+03 M2          APPLIED VOLTAGE =  2.913E+04 VOLTS       TOTAL CURRENT =  1.420E+00 AMPS
WIRE TO PLATE =  1.143E-01 M             CORONA WIRE RADIUS =  1.384E-03 M        CORONA WIRE LENGTH =  1.713E+04 M
CURRENT/M =  8,290E-05 AMP/M             CURRENT DENSITY =  3.625E-04 AMP/M2      DEPOSIT E FIELD =  6.888E+04 VOLT/M
1/2 WIRE TO WIRE =  1.143E-01 M          GAS FLOW RATE =  2.044E+02 M3/SEC        GAS VELOCITY =  1.158E+00 M/SEC
TEMPERATURE = 601,667 K                  PRESSURE =    1,000 ATM                  VISCOSITY =  2,800E-05 KG/M-SEC
ION MOBILITY =  4,846E-04 M2/VOLT-SEC  MEAN THERMAL SPEED =  6.311E+02 M/SEC     PART. PATH PARAM. =  1.154E-07 M
DUST WEIGHT =  1,175E+00 KG/SEC          LENGTH INCR. = .30500000 M               INPUT EFF./INCR. = 16,57

ROVRI     ERAVG        EPLT         AFID        CMCD      MMD        WEIGHT      DUST LAYER   J(PART)      J(ION)    INCR. NO.

1,0019   2,549E+05  1,5280E+05  1,8311E+13     36,3   1,94E-06   6,299E-06   1,775E-04   9,58E-08   3,62E-04      19
1,0014   2,549E+05  1,5280E+05  1,8320E+13     36,3   1,91E-06   5,535E-06   1,559E-04   8,76E-08   3,62E-04      20
1,0011   2,549E+05  1,5280E+05  1,8326E+13     36,3   1,87E-06   4.873E-06   1,373E-04   8,01E-08   3,62E-04      21
1,0008   2,549E+05  1,5280E+05  1,8331E+13     36,3   1,83E-06   4,299E-06   1,211E-04   7,33E-08   3,62E-04      22
1,0006   2,549E+05  1,5280E+05  1,8334E+13     36,3   1,80E-06   3,800E-06   1,070E-04   6,71E-08   3,62E-04      23
1,0005   2,549E+05  1,5280E+05  1,8337E+13     36,3   1,76E-06   3,364E-06   9,477E-05   6,15E-08   3,62E-04      24
1,0004   2,549E+05  1,5280E+05  1,8339E+13     36,3   1,71E-06   2,983E-06   8,403E-05   5,64E-08   3,62E-04      25
1,0003   2,549E+05  1,5280E+05  1,8341E+13     36,3   1,66E-06   2,648E-06   7.461E-05   5,16E-08   3,62E-04      26
1,0002   2,549E+05  1,5280E+05  1,8342E+13     36,3   1,61E-06   2,355E-06   6,634E-05   4,73E-08   3,62E-04      27
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CALCULATION IS IN SECTION NO. = 4 AND THE SECTION LENGTH IS =  2.7450 M

COLLECTION AREA =  3,917E+03 M2          APPLIED VOLTAGE =  2.750E+04 VOLTS        TOTAL CURRENT =  1.460E+00 AMPS
WIRE TO PLATE =  1.143E-01 M             CORONA WIRE RADIUS =  1.384E-03 M          CORONA WIRE LENGTH =  1.713E+04 M
CURRENT/M =  8,524E-05 AMP/M             CURRENT DENSITY =  3.727E-04 AMP/M2        DEPOSIT E FIELD =  7.082E+04 VOLT/M
1/2 WIRE TO WIRE =  1.143E-01 M          GAS FLOW RATE =  2.044E+02 M3/SEC          GAS VELOCITY =  1.158E+00 M/SEC
TEMPERATURE = 601.667 K                  PRESSURE =   1.000 ATM                     VISCOSITY =  2.800E-05 KG/M-SEC
ION MOBILITY =  4.846E-04 M2/VOLT-SEC    MEAN THERMAL SPEED =  6.311E+02 M/SEC      PART. PATH PARAM. =  1.154E-07 M
DUST WEIGHT =  1.175E+00 KG/SEC          LENGTH INCR. = .30500000 M                 INPUT EFF./INCR. = 16.57

ROVRI     ERAVG       EPLT        AFID        CMCD     MMD        WEIGHT     DUST LAYER   J(PART)     J(ION)    INCR. NO.

1,0002  2,406E+05  1,5105E+05  1,9978E+13   37,3   1,56E-06   2,074E-06   5,843E-05   4,29E-08   3,73E-04      28
1,0001  2,406E+05  1,5105E+05  1,9978E+13   37,3   1,51E-06   1,851E-06   5,216E-05   3,93E-08   3,73E-04      29
1,0001  2,406E+05  1,5105E+05  1,9979E+13   37,3   1,46E-06   1,655E-06   4,662E-05   3,61E-08   3,73E-04      30
1,0001  2,406E+05  1,5105E+05  1,9979E+13   37,3   1,41E-06   1,481E-06   4,172E-05   3,32E-08   3,73E-04      31
1,0001  2,406E+05  1,5105E+05  1,9980E+13   37,3   1,36E-06   1,327E-06   3,738E-05   3,05E-08   3,73E-04      32
1,0000  2,406E+05  1,5105E+05  1,9980E+13   37,3   1,32E-06   1,190E-06   3,353E-05   2,81E-08   3,73E-04      33
1,0000  2,406E+05  1,5105E+05  1,9980E+13   37,3   1,27E-06   1,069E-06   3,011E-05   2,58E-08   3,73E-04      34
1,0000  2,406E+05  1,5105E+05  1,9980E+13   37,3   1,23E-06   9,606E-07   2,706E-05   2,38E-08   3,73E-04      35
1,0000  2,406E+05  1,5105E+05  1,9980E+13   37,3   1,20E-06   8,644E-07   2,435E-05   2,19E-08   3,73E-04      36

EST EFFICIENCY = 99,85     COMPUTED EFFICIENCY = 99,85     CONVERGES
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CHARGING RATES FOR PARTICLE SIZES FROM SUBROUTINE CHARGE OR CHGSUM

SRI THEORY USED FOR PARTICLE CHARGING

INCREMENT NO.     Q/QSATF FOR INDICATED PARTICLE SIZES

   0.3000E-06   0.5500E-06   0.8500E-06   0.1250E-05   0.1750E-05   0.2500E-05   0.3500E-05   0.4500E-05
 1  1.3047       1.3047       1.3047       1.2676       1.2133       1.1674       1.1335       1.1135
 2  1.6749       1.6647       1.5913       1.5019       1.4218       1.3524       1.2931       1.2504
 3  1.8838       1.8440       1.7295       1.6101       1.5130       1.4321       1.3739       1.3336
 4  2.0295       1.9637       1.8208       1.6807       1.5706       1.4797       1.4158       1.3757
 5  2.1411       2.0533       1.8888       1.7329       1.6128       1.5137       1.4443       1.4020
 6  2.2312       2.1246       1.9429       1.7743       1.6459       1.5400       1.4658       1.4211
 7  2.3065       2.1836       1.9875       1.8084       1.6730       1.5614       1.4830       1.4360
 8  2.3710       2.2338       2.0254       1.8373       1.6960       1.5794       1.4973       1.4483
 9  2.4272       2.2774       2.0582       1.8623       1.7158       1.5948       1.5096       1.4586
10  2.4905       2.3229       2.0901       1.8844       1.7314       1.6052       1.5162       1.4631
11  2.5452       2.3624       2.1180       1.9040       1.7454       1.6145       1.5162       1.4631
12  2.5933       2.3973       2.1428       1.9215       1.7580       1.6231       1.5162       1.4631
13  2.6362       2.4285       2.1651       1.9374       1.7695       1.6310       1.5162       1.4631
14  2.6748       2.4567       2.1853       1.9518       1.7801       1.6310       1.5162       1.4631
15  2.7100       2.4824       2.2038       1.9651       1.7898       1.6310       1.5162       1.4631
16  2.7423       2.5060       2.2208       1.9774       1.7989       1.6310       1.5162       1.4631
17  2.7720       2.5278       2.2366       1.9889       1.8073       1.6310       1.5162       1.4631
18  2.7996       2.5481       2.2513       1.9995       1.8073       1.6310       1.5162       1.4631
19  2.8178       2.5590       2.2577       2.0030       1.8073       1.6310       1.5162       1.4631
20  2.8352       2.5590       2.2577       2.0030       1.8073       1.6310       1.5162       1.4631
21  2.8517       2.5590       2.2577       2.0030       1.8073       1.6310       1.5162       1.4631
22  2.8676       2.5590       2.2577       2.0030       1.8073       1.6310       1.5162       1.4631
23  2.8828       2.5590       2.2577       2.0030       1.8073       1.6310       1.5162       1.4631
24  2.8974       2.5590       2.2577       2.0030       1.8073       1.6310       1.5162       1.4631
25  2.9114       2.5590       2.2577       2.0030       1.8073       1.6310       1.5162       1.4631
26  2.9114       2.5590       2.2577       2.0030       1.8073       1.6310       1.5162       1.4631
27  2.9114       2.5590       2.2577       2.0030       1.8073       1.6310       1.5162       1.4631
28  2.9114       2.5590       2.2577       2.0030       1.8073       1.6310       1.5162       1.4631
29  2.9114       2.5590       2.2577       2.0030       1.8073       1.6310       1.5162       1.4631
30  2.9114       2.5590       2.2577       2.0030       1.8073       1.6310       1.5162       1.4631
31  2.9114       2.5590       2.2577       2.0030       1.8073       1.6310       1.5162       1.4631
32  2.9114       2.5590       2.2577       2.0030       1.8073       1.6310       1.5162       1.4631
33  2.9114       2.5590       2.2577       2.0030       1.8073       1.6310       1.5162       1.4631
34  2.9114       2.5590       2.2577       2.0030       1.8073       1.6310       1.5162       1.4631
35  2.9114       2.5590       2.2577       2.0030       1.8073       1.6310       1.5162       1.4631
36  2.9114       2.5590       2.2577       2.0030       1.8073       1.6310       1.5162       1.4631

   0.6000E-05   0.8500E-05   0.1250E-04   0.2000E-04   0.2750E-04   0.6500E-04
 1  1.0966       1.0846       1.0795       1.0784       1.0783       1.0782
 2  1.2170       1.1956       1.1876       1.1861       1.1861       1.1860
 3  1.2789       1.2419       1.2291       1.2267       1.2267       1.2266
 4  1.3295       1.2707       1.2511       1.2476       1.2475       1.2475
 5  1.3575       1.2950       1.2651       1.2602       1.2600       1.2600
 6  1.3757       1.3204       1.2752       1.2686       1.2683       1.2683
 7  1.3893       1.3366       1.2832       1.2745       1.2741       1.2741
 8  1.4001       1.3478       1.2902       1.2745       1.2741       1.2741
 9  1.4090       1.3564       1.2970       1.2745       1.2741       1.2741
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10  1.4118      1.3580      1.2984      1.2745      1.2741      1.2741
11  1.4118      1.3580      1.2984      1.2745      1.2741      1.2741
12  1.4118      1.3580      1.2984      1.2745      1.2741      1.2741
13  1.4118      1.3580      1.2984      1.2745      1.2741      1.2741
14  1.4118      1.3580      1.2984      1.2745      1.2741      1.2741
15  1.4118      1.3580      1.2984      1.2745      1.2741      1.2741
16  1.4118      1.3580      1.2984      1.2745      1.2741      1.2741
17  1.4118      1.3580      1.2984      1.2745      1.2741      1.2741
18  1.4118      1.3580      1.2984      1.2745      1.2741      1.2741
19  1.4118      1.3580      1.2984      1.2745      1.2741      1.2741
20  1.4118      1.3580      1.2984      1.2745      1.2741      1.2741
21  1.4118      1.3580      1.2984      1.2745      1.2741      1.2741
22  1.4118      1.3580      1.2984      1.2745      1.2741      1.2741
23  1.4118      1.3580      1.2984      1.2745      1.2741      1.2741
24  1.4118      1.3580      1.2984      1.2745      1.2741      1.2741
25  1.4118      1.3580      1.2984      1.2745      1.2741      1.2741
26  1.4118      1.3580      1.2984      1.2745      1.2741      1.2741
27  1.4118      1.3580      1.2984      1.2745      1.2741      1.2741
28  1.4118      1.3580      1.2984      1.2745      1.2741      1.2741
29  1.4118      1.3580      1.2984      1.2745      1.2741      1.2741
30  1.4118      1.3580      1.2984      1.2745      1.2741      1.2741
31  1.4118      1.3580      1.2984      1.2745      1.2741      1.2741
32  1.4118      1.3580      1.2984      1.2745      1.2741      1.2741
33  1.4118      1.3580      1.2984      1.2745      1.2741      1.2741
34  1.4118      1.3580      1.2984      1.2745      1.2741      1.2741
35  1.4118      1.3580      1.2984      1.2745      1.2741      1.2741
36  1.4118      1.3580      1.2984      1.2745      1.2741      1.2741
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  CHARGE ACCUMULATED ON PARTICLE SIZES IN EACH INCREMENT

INCREMENT        CHARGE FOR INDICATED PARTICLE SIZES

        0,3000E-06   0,5500E-06   0,8500E-06   0,1250E-05   0.1750E-05   0.2500E-05   0.3500E-05   0.4500E-05
   1   0,39845E-17  0,10717E-16  0,23786E-16  0,48363E-16  0.89364E-16  0.17396E-15  0.32962E-15  0.53426E-15
   2   0,51151E-17  0,13673E-16  0,29010E-16  0,57305E-16  0.10472E-15  0.20153E-15  0.37605E-15  0.59993E-15
   3   0,57531E-17  0,15146E-16  0,31529E-16  0,61431E-16  0.11144E-15  0.21341E-15  0.39953E-15  0.63985E-15
   4   0,61981E-17  0,16129E-16  0,33194E-16  0,64123E-16  0.11568E-15  0.22051E-15  0.41172E-15  0.66005E-15
   5   0,65368E-17  0,16865E-16  0,34434E-16  0,66117E-16  0.11879E-15  0.22557E-15  0.42000E-15  0.67265E-15
   6   0,68140E-17  0,17451E-16  0,35419E-16  0,67696E-16  0.12123E-15  0.22949E-15  0.42625E-15  0.68181E-15
   7   0,70439E-17  0,17936E-16  0,36232E-16  0,68997E-16  0.12323E-15  0.23266E-15  0.43126E-15  0.68899E-15
   8   0,72408E-17  0,18348E-16  0,36923E-16  0,70100E-16  0.12492E-15  0.23535E-15  0.43543E-15  0.69488E-15
   9   0,74124E-17  0,18705E-16  0,37522E-16  0,71055E-16  0.12638E-15  0.23766E-15  0.43899E-15  0.69985E-15
  10   0,76057E-17  0,19079E-16  0,38102E-16  0,71897E-16  0.12752E-15  0.23920E-15  0.44090E-15  0.70201E-15
  11   0,77728E-17  0,19404E-16  0,38611E-16  0,72644E-16  0.12855E-15  0.24059E-15  0.44090E-15  0.70201E-15
  12   0,79197E-17  0,19691E-16  0,39063E-16  0,73312E-16  0.12948E-15  0.24187E-15  0.44090E-15  0.70201E-15
  13   0,80506E-17  0,19947E-16  0,39469E-16  0,73917E-16  0.13033E-15  0.24304E-15  0.44090E-15  0.70201E-15
  14   0,81687E-17  0,20179E-16  0,39838E-16  0,74470E-16  0.13111E-15  0.24304E-15  0.44090E-15  0.70201E-15
  15   0,82761E-17  0,20390E-16  0,40176E-16  0,74977E-16  0.13183E-15  0.24304E-15  0.44090E-15  0.70201E-15
  16   0,83746E-17  0,20584E-16  0,40486E-16  0,75446E-16  0.13250E-15  0.24304E-15  0.44090E-15  0.70201E-15
  17   0,84655E-17  0,20763E-16  0,40774E-16  0,75882E-16  0.13312E-15  0.24304E-15  0.44090E-15  0.70201E-15
  18   0,85499E-17  0,20929E-16  0,41042E-16  0,76289E-16  0.13312E-15  0.24304E-15  0.44090E-15  0.70201E-15
  19   0,86054E-17  0,21019E-16  0,41158E-16  0,76423E-16  0.13312E-15  0.24304E-15  0.44090E-15  0.70201E-15
  20   0,86584E-17  0,21019E-16  0,41158E-16  0,76423E-16  0.13312E-15  0.24304E-15  0.44090E-15  0.70201E-15
  21   0,87090E-17  0,21019E-16  0,41158E-16  0,76423E-16  0.13312E-15  0.24304E-15  0.44090E-15  0.70201E-15
  22   0,87574E-17  0,21019E-16  0,41158E-16  0,76423E-16  0.13312E-15  0.24304E-15  0.44090E-15  0.70201E-15
  23   0,88038E-17  0,21019E-16  0,41158E-16  0,76423E-16  0.13312E-15  0.24304E-15  0.44090E-15  0.70201E-15
  24   0,88484E-17  0,21019E-16  0,41158E-16  0,76423E-16  0.13312E-15  0.24304E-15  0.44090E-15  0.70201E-15
  25   0,88913E-17  0,21019E-16  0,41158E-16  0,76423E-16  0.13312E-15  0.24304E-15  0.44090E-15  0.70201E-15
  26   0,88913E-17  0,21019E-16  0,41158E-16  0,76423E-16  0.13312E-15  0.24304E-15  0.44090E-15  0.70201E-15
  27   0,88913E-17  0,21019E-16  0,41158E-16  0,76423E-16  0.13312E-15  0.24304E-15  0.44090E-15  0.70201E-15
  28   0,88913E-17  0,21019E-16  0,41158E-16  0,76423E-16  0.13312E-15  0.24304E-15  0.44090E-15  0.70201E-15
  29   0,88913E-17  0,21019E-16  0,41158E-16  0,76423E-16  0.13312E-15  0.24304E-15  0.44090E-15  0.70201E-15
  30   0,88913E-17  0,21019E-16  0,41158E-16  0,76423E-16  0.13312E-15  0.24304E-15  0.44090E-15  0.70201E-15
  31   0,88913E-17  0,21019E-16  0,41158E-16  0,76423E-16  0.13312E-15  0.24304E-15  0.44090E-15  0.70201E-15
  32   0,88913E-17  0,21019E-16  0,41158E-16  0,76423E-16  0.13312E-15  0.24304E-15  0.44090E-15  0.70201E-15
  33   0,88913E-17  0,21019E-16  0,41158E-16  0,76423E-16  0.13312E-15  0.24304E-15  0.44090E-15  0.70201E-15
  34   0,88913E-17  0,21019E-16  0,41158E-16  0,76423E-16  0.13312E-15  0.24304E-15  0.44090E-15  0.70201E-15
  35   0,88913E-17  0,21019E-16  0,41158E-16  0,76423E-16  0.13312E-15  0.24304E-15  0.44090E-15  0.70201E-15
  36   0,88913E-17  0,21019E-16  0,41158E-16  0,76423E-16  0.13312E-15  0.24304E-15  0.44090E-15  0.70201E-15

        0,6000E-05   0,8500E-05   0,1250E-04   0,2000E-04   0.2750E-04   0.6500E-04
   1   0,93411E-15  0,16524E-14  0,39852E-14  0,10188E-13  0.19257E-13  0.10756E-12
   2   0,10366E-14  0,20421E-14  0,43841E-14  0,11205E-13  0.21181E-13  0.11831E-12
   3   0,10894E-14  0,21210E-14  0,45371E-14  0,11589E-13  0.21907E-13  0.12237E-12
   4   0,11325E-14  0,21702E-14  0,46185E-14  0,11787E-13  0.22279E-13  0.12445E-12
   5   0,11563E-14  0,22118E-14  0,46703E-14  0,11906E-13  0.22503E-13  0.12570E-12
   6   0,11719E-14  0,22551E-14  0,47075E-14  0,11984E-13  0.22650E-13  0.12652E-12
   7   0,11834E-14  0,22827E-14  0,47371E-14  0,12040E-13  0.22754E-13  0.12710E-12
   8   0,11926E-14  0,23019E-14  0,47630E-14  0,12040E-13  0.22754E-13  0.12710E-12
   9   0,12002E-14  0,23166E-14  0,47880E-14  0,12040E-13  0.22754E-13  0.12710E-12
  10   0,12026E-14  0,23193E-14  0,47930E-14  0,12040E-13  0.22754E-13  0.12710E-12
  11   0,12026E-14  0,23193E-14  0,47930E-14  0,12040E-13  0.22754E-13  0.12710E-12
  12   0,12026E-14  0,23193E-14  0,47930E-14  0,12040E-13  0.22754E-13  0.12710E-12
  13   0,12026E-14  0,23193E-14  0,47930E-14  0,12040E-13  0.22754E-13  0.12710E-12
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14    0.12026E-14    0.23193E-14    0.47930E-14    0.12040E-13    0.22754E-13    0.12710E-12
15    0.12026E-14    0.23193E-14    0.47930E-14    0.12040E-13    0.22754E-13    0.12710E-12
16    0.12026E-14    0.23193E-14    0.47930E-14    0.12040E-13    0.22754E-13    0.12710E-12
17    0.12026E-14    0.23193E-14    0.47930E-14    0.12040E-13    0.22754E-13    0.12710E-12
18    0.12026E-14    0.23193E-14    0.47930E-14    0.12040E-13    0.22754E-13    0.12710E-12
19    0.12026E-14    0.23193E-14    0.47930E-14    0.12040E-13    0.22754E-13    0.12710E-12
20    0.12026E-14    0.23193E-14    0.47930E-14    0.12040E-13    0.22754E-13    0.12710E-12
21    0.12026E-14    0.23193E-14    0.47930E-14    0.12040E-13    0.22754E-13    0.12710E-12
22    0.12026E-14    0.23193E-14    0.47930E-14    0.12040E-13    0.22754E-13    0.12710E-12
23    0.12026E-14    0.23193E-14    0.47930E-14    0.12040E-13    0.22754E-13    0.12710E-12
24    0.12026E-14    0.23193E-14    0.47930E-14    0.12040E-13    0.22754E-13    0.12710E-12
25    0.12026E-14    0.23193E-14    0.47930E-14    0.12040E-13    0.22754E-13    0.12710E-12
26    0.12026E-14    0.23193E-14    0.47930E-14    0.12040E-13    0.22754E-13    0.12710E-12
27    0.12026E-14    0.23193E-14    0.47930E-14    0.12040E-13    0.22754E-13    0.12710E-12
28    0.12026E-14    0.23193E-14    0.47930E-14    0.12040E-13    0.22754E-13    0.12710E-12
29    0.12026E-14    0.23193E-14    0.47930E-14    0.12040E-13    0.22754E-13    0.12710E-12
30    0.12026E-14    0.23193E-14    0.47930E-14    0.12040E-13    0.22754E-13    0.12710E-12
31    0.12026E-14    0.23193E-14    0.47930E-14    0.12040E-13    0.22754E-13    0.12710E-12
32    0.12026E-14    0.23193E-14    0.47930E-14    0.12040E-13    0.22754E-13    0.12710E-12
33    0.12026E-14    0.23193E-14    0.47930E-14    0.12040E-13    0.22754E-13    0.12710E-12
34    0.12026E-14    0.23193E-14    0.47930E-14    0.12040E-13    0.22754E-13    0.12710E-12
35    0.12026E-14    0.23193E-14    0.47930E-14    0.12040E-13    0.22754E-13    0.12710E-12
36    0.12026E-14    0.23193E-14    0.47930E-14    0.12040E-13    0.22754E-13    0.12710E-12
```

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PARTICLE SIZE RANGE STATISTICS

CORRECTIONS FOR NONIDEALITIES USING SET NO.  1 OF CORRECTION PARAMETERS

  SIZE      CCF  INLET % OUTLET % COR. OUTLET % NO-RAP EFF. NO-RAP W  NO-RAP P  COR. EFF.   COR. W     COR. P
3.000E-07  2.040  0.148   2.1197      0.6218      99.6590     7.410    0.3410   99.5850    7.154     0.4150
5.500E-07  1.540  0.426  11.8587      3.4639      99.3381     6.545    0.6619   99.1981    6.295     0.8019
8.500E-07  1.343  0.435  11.6939      4.0636      99.3494     6.567    0.6506   99.0780    6.113     0.9220
1.250E-06  1.232  0.713  14.4435      6.5124      99.5162     6.959    0.4818   99.0991    6.143     0.9009
1.750E-06  1.166  1.027  14.1444      7.2182      99.6722     7.461    0.3278   99.3061    6.483     0.6939
2.500E-06  1.116  3.776  29.7416     15.4836      99.8126     8.190    0.1874   99.5953    7.186     0.4047
3.500E-06  1.083  2.958  11.5296     10.7099      99.9073     9.108    0.0927   99.6427    7.349     0.3573
4.500E-06  1.064  1.653   3.3599      7.8058      99.9516     9.957    0.0484   99.5340    7.002     0.4660
6.000E-06  1.048  1.914   0.5064     11.1891      99.9937    12.612    0.0063   99.4231    6.724     0.5769
8.500E-06  1.034  2.575   0.0454     10.9973      99.9996    16.151    0.0004   99.5785    7.134     0.4215
1.250E-05  1.023  4.559   0.0192      9.8723      99.9999    22.456    0.0001   99.7863    8.019     0.2137
2.000E-05  1.015 10.788   0.0454      7.5200      99.9999    34.957    0.0001   99.9312    9.498     0.0688
2.750E-05  1.011  4.524   0.0190      1.5326      99.9999    47.860    0.0001   99.9666   10.439     0.0334
6.500E-05  1.004 64.503   0.2714      3.0092      99.9999   112.423    0.0001   99.9954   13.025     0.0046
EFFICIENCIES FOR CONVERGENCE CHECK:  STATED OR PREVIOUS CALCULATION =  99.853   FINAL CALCULATION =  99.853


  ADJUSTED NO-RAP EFF. =  99.9762
  MMD OF INLET SIZE DISTRIBUTION =  5.172E+01
  SIGMAP OF INLET SIZE DISTRIBUTION =  5.542E+00
  LOG-NORMAL GOODNESS OF FIT =  0.992
  MMD OF EFFLUENT UNDER NO-RAP CONDITIONS =  1.551E+00
  SIGMAP OF EFFLUENT UNDER NO-RAP CONDITIONS =  1.920E+00
  LOG-NORMAL GOODNESS OF FIT =  0.989
  PRECIPITATION RATE PARAMETER UNDER NO-RAP CONDITIONS = 10.882


  SIGMAG=    0.000  WITH  0.000 SNEAKAGE OVER    4.000  STAGES
  NTEMP = 2
  RMMD =  6.00
  RSIGMA = 2.50
  CORR. EFF. =  99.9013
  CORRECTED MMD OF EFFLUENT =  4.398E+00
  CORRECTED SIGMAP OF EFFLUENT =  2.768E+00
  LOG-NORMAL GOODNESS OF FIT =  0.999
  CORRECTED PRECIPITATION RATE PARAMETER =    9.03
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UNADJUSTED MIGRATION VELOCITIES AND EFFICIENCIES, AND DISCRETE OUTLET MASS LOADINGS

IDEAL UNADJUSTED   IDEAL UNADJUSTED     NO-RAP     RAPPING PUFF   NO-RAP+RAP PUFF   RAPPING PUFF   PARTICLE
    MIG. VEL.         EFFICIENCY       DM/DLOGD      DP/DLOGD        DM/DLOGD      DISTRIBUTION      DIAM.
    (CM/SEC)             (%)          (MG/DSCM)     (MG/DSCM)       (MG/DSCM)          (%)            (M)
   3.308E+00          9.208E+01       2.127E-01     4.610E-02       2.588E-01       1.458E-01     3.000E-07
   3.331E+00          9.222E+01       1.474E+00     3.117E-01       1.785E+00       7.960E-01     5.500E-07
   3.731E+00          9.428E+01       2.319E+00     9.673E-01       3.286E+00       1.574E+00     8.500E-07
   4.370E+00          9.649E+01       2.477E+00     2.155E+00       4.633E+00       3.988E+00     1.250E-06
   5.199E+00          9.814E+01       3.419E+00     3.818E+00       7.237E+00       5.012E+00     1.750E-06
   6.449E+00          9.929E+01       5.101E+00     5.913E+00       1.101E+01       1.094E+01     2.500E-06
   8.169E+00          9.981E+01       2.787E+00     7.951E+00       1.074E+01       1.044E+01     3.500E-06
   9.957E+00          9.995E+01       1.047E+00     9.042E+00       1.009E+01       9.208E+00     4.500E-06
   1.261E+01          9.999E+01       1.051E-01     9.486E+00       9.591E+00       1.457E+01     6.000E-06
   1.615E+01          1.000E+02       8.654E-03     8.864E+00       8.893E+00       1.446E+01     8.500E-06
   2.246E+01          1.000E+02       3.290E-03     7.023E+00       7.026E+00       1.299E+01     1.250E-05
   3.496E+01          1.000E+02       6.180E-03     4.246E+00       4.252E+00       9.898E+00     2.000E-05
   4.786E+01          1.000E+02       7.262E-03     2.425E+00       2.432E+00       2.017E+00     2.750E-05
   1.124E+02          1.000E+02       1.568E-02     7.209E-01       7.366E-01       3.961E+00     6.500E-05
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******************************************************************************************
                              E.P.A. ESP MODEL
                         I.E.R.L.-R.T.P. AND SO.R.I.

                      SUMMARY TABLE OF ESP OPERATING
                        PARAMETERS AND PERFORMANCE


                              DATA SET NUMBER   1

                        NON-IDEAL CONDITION SET NUMBER  1

ESP PERFORMANCE:      EFFICIENCY =  99.9013 %      SCA =  7.667E+01 M**2/(M**3/SEC)

                                                         ( 389. FT**2/1000 ACFM)

ELECTRICAL CONDITIONS:     AVG. APPLIED VOLTAGE =  3.161E+04 V

                           AVG. CURRENT DENSITY =   36.84 NA/CM**2

                           RESISTIVITY =  1.900E+10 OHM-CM

SIZE DISTRIBUTIONS:      INLET MMD =  5.172E+01 UM      INLET SIGMAP =  5.542E+00

                         OUTLET MMD =  4.396E+00 UM     OUTLET SIGMAP =  2.768E+00

NONIDEAL PARAMETERS:     GAS SNEAKAGE FRACTION =  .00 /SECTION     GAS VELOCITY SIGMAG =  .00

                         RAPPING MMD =  6.000E+00 UM      RAPPING SIGMAP =  2.500E+00
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PARTICLE SIZE RANGE STATISTICS

CORRECTIONS FOR NONIDEALITIES USING SET NO.  2 OF CORRECTION PARAMETERS

   SIZE      CCF  INLET % OUTLET % COR. OUTLET % NO-RAP EFF. NO-RAP W  NO-RAP P  COR. EFF.   COR. W     COR. P
 3.000E-07  2.040  0.148   1.1736       0.5416      98.8258     5.797    1.1742   98.5926    5.561      1.4074
 5.500E-07  1.540  0.426   5.6988       2.6838      98.0219     5.117    1.9781   97.5803    4.854      2.4197
 8.500E-07  1.343  0.435   6.0143       3.2843      97.9541     5.073    2.0459   97.0961    4.617      2.9019
 1.250E-06  1.232  0.713   8.4517       5.7080      98.2470     5.274    1.7530   96.9248    4.541      3.0752
 1.750E-06  1.166  1.027  10.1042       6.9742      98.5436     5.516    1.4564   97.3889    4.755      2.6111
 2.500E-06  1.116  3.776  29.3003      18.0133      98.8517     5.826    1.1483   98.1664    5.216      1.8336
 3.500E-06  1.083  2.958  18.2847      13.4624      99.0853     6.123    0.9147   98.2508    5.277      1.7492
 4.500E-06  1.064  1.653   9.0564       9.1527      99.1893     6.280    0.8107   97.8719    5.022      2.1281
 6.000E-06  1.048  1.914   5.3043      11.0054      99.5899     7.169    0.4101   97.7900    4.972      2.2100
 8.500E-06  1.034  2.575   5.1526      10.8820      99.7039     7.594    0.2961   98.3759    5.374      1.6241
 1.250E-05  1.023  4.559   1.3684       8.5227      99.9556    10.068    0.0444   99.2815    6.438      0.7185
 2.000E-05  1.015 10.788   0.0441       6.0907      99.9994    34.957    0.0006   99.7830    7.999      0.2170
 2.750E-05  1.011  4.524   0.0031       1.2413      99.9999    47.860    0.0001   99.8945    8.941      0.1055
 6.500E-05  1.004 64.503   0.0436       2.4375      99.9999   112.423    0.0001   99.9855   11.526      0.0145

EFFICIENCIES FOR CONVERGENCE CHECK:  STATED OR PREVIOUS CALCULATION =  99.853   FINAL CALCULATION =  99.853

   ADJUSTED NO-RAP EFF. =  99.8520
   MMD OF INLET SIZE DISTRIBUTION =  5.172E+01
   SIGMAP OF INLET SIZE DISTRIBUTION =  5.542E+00
   LOG-NORMAL GOODNESS OF FIT =  0.992
   MMD OF EFFLUENT UNDER NO-RAP CONDITIONS =  2.299E+00
   SIGMAP OF EFFLUENT UNDER NO-RAP CONDITIONS =  2.070E+00
   LOG-NORMAL GOODNESS OF FIT =  0.994
   PRECIPITATION RATE PARAMETER UNDER NO-RAP CONDITIONS =  8.499


   SIGMAG=    0.250  WITH  0.100 SNEAKAGE OVER    4.000  STAGES
   NTEMP = 2
   RMMD =  6.00
   RSIGMA = 2.50
   CORR. EFF. =  99.6156
   CORRECTED MMD OF EFFLUENT =  4.290E+00
   CORRECTED SIGMAP OF EFFLUENT =  2.605E+00
   LOG-NORMAL GOODNESS OF FIT =  0.999
   CORRECTED PRECIPITATION RATE PARAMETER =    7.25
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UNADJUSTED MIGRATION VELOCITIES AND EFFICIENCIES, AND DISCRETE OUTLET MASS LOADINGS

IDEAL UNADJUSTED   IDEAL UNADJUSTED    NO-RAP      RAPPING PUFF   NO-RAP+RAP PUFF   RAPPING PUFF   PARTICLE
    MIG. VEL.        EFFICIENCY       DM/DLOGD       DM/DLOGD         DM/DLOGD      DISTRIBUTION     DIAM.
    (CM/SEC)             (%)         (MG/DSCM)      (MG/DSCM)        (MG/DSCM)          (%)           (M)
    3.308E+00         9.208E+01      7.322E-01      1.454E-01        8.776E-01       1.458E-01     3.000E-07
    3.331E+00         9.222E+01      4.404E+00      9.832E-01        5.387E+00       7.960E-01     5.500E-07
    3.731E+00         9.428E+01      7.292E+00      3.051E+00        1.034E+01       1.374E+00     8.500E-07
    4.370E+00         9.649E+01      9.014E+00      6.799E+00        1.581E+01       3.988E+00     1.250E-06
    5.199E+00         9.814E+01      1.519E+01      1.204E+01        2.723E+01       5.012E+00     1.750E-06
    6.449E+00         9.929E+01      3.125E+01      1.865E+01        4.990E+01       1.094E+01     2.500E-06
    8.169E+00         9.981E+01      2.749E+01      2.508E+01        5.256E+01       1.044E+01     3.500E-06
    9.957E+00         9.995E+01      1.755E+01      2.852E+01        4.607E+01       9.208E+00     4.500E-06
    1.261E+01         9.999E+01      6.817E+00      2.992E+01        3.674E+01       1.457E+01     6.000E-06
    1.615E+01         1.000E+02      6.247E+00      2.802E+01        3.427E+01       1.440E+01     8.500E-06
    2.246E+01         1.000E+02      1.459E+00      2.215E+01        2.361E+01       1.299E+01     1.250E-05
    3.496E+01         1.000E+02      3.732E-02      1.339E+01        1.343E+01       9.898E+00     2.000E-05
    4.786E+01         1.000E+02      7.262E-03      7.648E+00        7.655E+00       2.017E+00     2.750E-05
    1.124E+02         1.000E+02      1.568E-02      2.274E+00        2.290E+00       3.961E+00     6.500E-05
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                          E.P.A. ESP MODEL
                     I.E.R.L.-R.T.P. AND SO.R.I.

                    SUMMARY TABLE OF ESP OPERATING
                      PARAMETERS AND PERFORMANCE


                          DATA SET NUMBER   1

                    NON-IDEAL CONDITION SET NUMBER  2

ESP PERFORMANCE:     EFFICIENCY =  99.6156 %     SCA =  7.667E+01 M**2/(M**3/SEC)
                                                         ( 389. FT**2/1000 ACFM)

ELECTRICAL CONDITIONS:     AVG. APPLIED VOLTAGE =  3.161E+04 V
                           AVG. CURRENT DENSITY =   36.84 NA/CM**2
                           RESISTIVITY =  1.900E+10 OHM-CM

SIZE DISTRIBUTIONS:     INLET MMD =  5.172E+01 UM     INLET SIGMAP =  5.542E+00
                        OUTLET MMD =  4.290E+00 UM     OUTLET SIGMAP =  2.605E+00

NONIDEAL PARAMETERS:     GAS SNEAKAGE FRACTION =  .10 /SECTION     GAS VELOCITY SIGMAG =  .25
                         RAPPING MMD =  6.000E+00 UM     RAPPING SIGMAP =  2.500E+00
```

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APPENDIX E

OUTPUT DATA FROM EXAMPLE 5

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                         ****************************************
                         *                                      *
                         *           E.P.A. ESP MODEL           *
                         *                                      *
                         *      I.E.R.L.-R.T.P. AND SO.R.I.     *
                         *                                      *
                         *             REVISION III             *
                         *                                      *
                         ****************************************

PRINTOUT OF INPUT DATA FOR DATA SET NUMBER  1


DATA ON CARD NUMBER   1

NENDPT = 14   NDATA =  1   NRAP =  3   MODL =  0   NOPRNT =  2   PATHL = 17.50 FT   NCOMPS =  0   NWAVES =  0  NLAMBA =  0

DATA ON CARD NUMBER   2

FULL-SCALE,COLD-SIDE ESP:  PLANT A;  SCA=243FT2/1000ACFM; J=15.9UA/FT2

DATA ON CARD NUMBER   3

NEST =  2  NDIST =  1  NVI =  1  NX = 10  NY = 10  NITER =  1  NCALC =  1  NRAPD =  1  NEFF =  1  NTEMP =  1  NONID =  1

DATA ON CARD NUMBER   4

DL =  1.96600 GRN/ACF  PL =  27.0000 FT  ETAD = 99.60000 %  DD =  2270.00 KG/M**3  EPS =  1.000E+02
VRATIO =   1.2000  US =  .000220 M**2/V-SEC  FPATH =   1.0000  EBD = 1500000. V/M  RHOCGS =  5.00E+10 OHM-CM

DATA ON CARD NUMBER   5

ASHUCK( 1) =  .00  AZIBBY( 1) =  .00  AZNUMS( 1) =  3.0


DATA ON CARD NUMBER   6

ENDPT( 1) =    0.100 UM   ENDPT( 2) =    0.300 UM   ENDPT( 3) =    0.500 UM   ENDPT( 4) =    0.900 UM   ENDPT( 5) =    1.300 UM
ENDPT( 6) =    1.900 UM   ENDPT( 7) =    3.100 UM   ENDPT( 8) =    3.900 UM   ENDPT( 9) =    5.100 UM   ENDPT(10) =    6.900 UM


DATA ON CARD NUMBER   7

ENDPT(11) =   10.100 UM   ENDPT(12) =   14.900 UM   ENDPT(13) =   25.100 UM   ENDPT(14) =   29.900 UM
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DATA ON CARD NUMBER   8

PRCU( 1) =   0.0000 %   PRCU( 2) =   0.0330 %   PRCU( 3) =   0.2860 %   PRCU( 4) =   1.1890 %   PRCU( 5) =   2.0040 %
PRCU( 6) =   3.5240 %   PRCU( 7) =   7.0480 %   PRCU( 8) =   8.7000 %   PRCU( 9) =  10.3520 %   PRCU(10) =  12.3340 %

DATA ON CARD NUMBER   9

PRCU(11) =  15.6380 %   PRCU(12) =  20.4840 %   PRCU(13) =  32.5990 %   PRCU(14) = 100.0000 %

DATA ON CARD NUMBER  10

NUMSEC =  3    LSECT( 1) = 10  LSECT( 2) = 10  LSECT( 3) = 10

DATA ON CARD NUMBER  11

AS( 1) =  2.6460E+04 FT**2  VOS( 1) =  4.0600E+04 V  TCS( 1) =  2.7300E-01 A  WLS( 1) =  1.5720E+04 FT
ACS( 1) =  8.2500E-02 IN  BS( 1) =  5.5000E+00 IN  NWS( 1) =  1.2000E+01

DATA ON CARD NUMBER  12

SYS( 1) =  3.6250E+00 IN  VGS( 1) =  3.2724E+05 FT**3/MIN  VGASS( 1) =  4.1000E+00 FT/SEC  TEMPS( 1) =  3.1500E+02 F
PS( 1) =  1.0000E+00 ATM  VISS( 1) =  2.2900E-05 KG/M-SEC  LINCS( 1) =  9.0000E-01 FT

DATA ON CARD NUMBER  13

AS( 2) =  2.6460E+04 FT**2  VOS( 2) =  4.2100E+04 V  TCS( 2) =  4.3300E-01 A  WLS( 2) =  1.5720E+04 FT
ACS( 2) =  8.2500E-02 IN  BS( 2) =  5.5000E+00 IN  NWS( 2) =  1.2000E+01

DATA ON CARD NUMBER  14

SYS( 2) =  3.6250E+00 IN  VGS( 2) =  3.2724E+05 FT**3/MIN  VGASS( 2) =  4.1000E+00 FT/SEC  TEMPS( 2) =  3.1500E+02 F
PS( 2) =  1.0000E+00 ATM  VISS( 2) =  2.2900E-05 KG/M-SEC  LINCS( 2) =  9.0000E-01 FT

DATA ON CARD NUMBER  15

AS( 3) =  2.6460E+04 FT**2  VOS( 3) =  4.2450E+04 V  TCS( 3) =  5.5800E-01 A  WLS( 3) =  1.5720E+04 FT
ACS( 3) =  8.2500E-02 IN  BS( 3) =  5.5000E+00 IN  NWS( 3) =  1.2000E+01

DATA ON CARD NUMBER  16

SYS( 3) =  3.6250E+00 IN  VGS( 3) =  3.2724E+05 FT**3/MIN  VGASS( 3) =  4.1000E+00 FT/SEC  TEMPS( 3) =  3.1500E+02 F
PS( 3) =  1.0000E+00 ATM  VISS( 3) =  2.2900E-05 KG/M-SEC  LINCS( 3) =  9.0000E-01 FT
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EST. EFFICIENCY = 99.60     UNCORRECTED COMPUTED EFFICIENCY = 99.34

RAP INCREMENTS 111111111100000000000000000000000000000000000  AT TIME    6.00  MIN

 .0001750  DUST REENTRAINED WITH PROFILE =

NORMALIZED CURVE:
                        1.000
                        1.000
                        1.000

WITH MMD:
                       10.000     1.500
                       10.000     1.500
                       10.000     1.500

DURATION IN SEC:     315.000

RAPPING PUFF PARTICLE DENSITY:   2000.

THE TIME IS   6.000  MIN
   0.21 % PEN =  0.148E-02 KG/SEC FOR  0.533E+00 KG ACCUM PEN AND  0.148E-02 KG/SEC AVG PEN

THE TIME IS  11.323  MIN
   0.23 % PEN =  0.163E-02 KG/SEC FOR  0.105E+01 KG ACCUM PEN AND  0.155E-02 KG/SEC AVG PEN

 OP=  8.581E+00        2.590E-01        8.818E+00-------------- % ------------- 7.992E+00        2.533E-01        8.225E+00

END OF RAP

CUMULATIVE PENETRATION =    0.22 %

TOTAL PENETRATION FOR THIS PUFF = 0.520E+00 KG


RAP INCREMENTS 111111111122222222222000000000000000000000000  AT TIME   12.00  MIN WITH THE SAME PROFILE @  0.0001750

THE TIME IS  12.000  MIN
   0.21 % PEN =  0.148E-02 KG/SEC FOR  0.111E+01 KG ACCUM PEN AND  0.155E-02 KG/SEC AVG PEN

THE TIME IS  17.287  MIN
   0.27 % PEN =  0.187E-02 KG/SEC FOR  0.171E+01 KG ACCUM PEN AND  0.165E-02 KG/SEC AVG PEN

 OP=  8.581E+00        5.291E-01        9.065E+00-------------- % ------------- 7.992E+00        5.223E-01        8.473E+00

END OF RAP

CUMULATIVE PENETRATION =    0.24 %

TOTAL PENETRATION FOR THIS PUFF = 0.593E+00 KG


RAP INCREMENTS 111111111100000000000000000000000000000000000  AT TIME   18.00  MIN WITH THE SAME PROFILE @  0.0001750
```

```
THE TIME IS  18.000  MIN
   0.21 % PEN =  0.148E-02 KG/SEC FOR  0.177E+01 KG ACCUM PEN AND  0.164E-02 KG/SEC AVG PEN

THE TIME IS  23.323  MIN
   0.25 % PEN =  0.171E-02 KG/SEC FOR  0.232E+01 KG ACCUM PEN AND  0.166E-02 KG/SEC AVG PEN

 OP=  8.581E+00        3.755E-01        8.925E+00-------------- % ------------- 7.992E+00        3.691E-01        8.332E+00

END OF RAP

CUMULATIVE PENETRATION =    0.24 %

TOTAL PENETRATION FOR THIS PUFF = 0.546E+00 KG


RAP INCREMENTS 111111111122222222220000000000000000000000000  AT TIME   24.00  MIN WITH THE SAME PROFILE @  0.0001750

THE TIME IS  24.000  MIN
   0.21 % PEN =  0.148E-02 KG/SEC FOR  0.238E+01 KG ACCUM PEN AND  0.165E-02 KG/SEC AVG PEN

THE TIME IS  29.287  MIN
   0.30 % PEN =  0.208E-02 KG/SEC FOR  0.304E+01 KG ACCUM PEN AND  0.173E-02 KG/SEC AVG PEN

 OP=  8.581E+00        7.468E-01        9.264E+00-------------- % ------------- 7.992E+00        7.394E-01        8.672E+00

END OF RAP

CUMULATIVE PENETRATION =    0.25 %

TOTAL PENETRATION FOR THIS PUFF = 0.660E+00 KG


RAP INCREMENTS 111111111122222222220000000000000000000000000  AT TIME   30.00  MIN WITH THE SAME PROFILE @  0.0001750

THE TIME IS  30.000  MIN
   0.21 % PEN =  0.148E-02 KG/SEC FOR  0.310E+01 KG ACCUM PEN AND  0.172E-02 KG/SEC AVG PEN

THE TIME IS  35.287  MIN
   0.29 % PEN =  0.202E-02 KG/SEC FOR  0.374E+01 KG ACCUM PEN AND  0.177E-02 KG/SEC AVG PEN

 OP=  8.581E+00        6.778E-01        9.201E+00-------------- % ------------- 7.992E+00        6.706E-01        8.609E+00

END OF RAP

CUMULATIVE PENETRATION =    0.25 %

TOTAL PENETRATION FOR THIS PUFF = 0.639E+00 KG


RAP INCREMENTS 111111111100000000000000000000000000000000000  AT TIME   36.00  MIN WITH THE SAME PROFILE @  0.0001750
```

```
THE TIME IS  36.000  MIN
   0.21 % PEN =  0.148E-02 KG/SEC FOR  0.380E+01 KG ACCUM PEN AND  0.176E-02 KG/SEC AVG PEN

THE TIME IS  41.323  MIN
   0.25 % PEN =  0.172E-02 KG/SEC FOR  0.435E+01 KG ACCUM PEN AND  0.175E-02 KG/SEC AVG PEN

 OP=  8.581E+00        3.817E-01        8.930E+00-------------- % ------------- 7.992E+00        3.753E-01        8.337E+00

END OF RAP

CUMULATIVE PENETRATION =    0.25 %

TOTAL PENETRATION FOR THIS PUFF = 0.548E+00 KG


RAP INCREMENTS 111111111122222222222000000000000000000000000  AT TIME   42.00  MIN WITH THE SAME PROFILE @  0.0001750

THE TIME IS  42.000  MIN
   0.21 % PEN =  0.148E-02 KG/SEC FOR  0.441E+01 KG ACCUM PEN AND  0.175E-02 KG/SEC AVG PEN

THE TIME IS  47.287  MIN
   0.31 % PEN =  0.214E-02 KG/SEC FOR  0.509E+01 KG ACCUM PEN AND  0.179E-02 KG/SEC AVG PEN

 OP=  8.581E+00        8.028E-01        9.315E+00-------------- % ------------- 7.992E+00        7.953E-01        8.724E+00

END OF RAP

CUMULATIVE PENETRATION =    0.26 %

TOTAL PENETRATION FOR THIS PUFF = 0.677E+00 KG


RAP INCREMENTS 111111111122222222222000000000000000000000000  AT TIME   48.00  MIN WITH THE SAME PROFILE @  0.0001750

THE TIME IS  48.000  MIN
   0.21 % PEN =  0.148E-02 KG/SEC FOR  0.515E+01 KG ACCUM PEN AND  0.179E-02 KG/SEC AVG PEN

THE TIME IS  53.287  MIN
   0.29 % PEN =  0.204E-02 KG/SEC FOR  0.580E+01 KG ACCUM PEN AND  0.181E-02 KG/SEC AVG PEN

 OP=  8.581E+00        6.957E-01        9.217E+00-------------- % ------------- 7.992E+00        6.883E-01        8.625E+00

END OF RAP

CUMULATIVE PENETRATION =    0.26 %

TOTAL PENETRATION FOR THIS PUFF = 0.645E+00 KG


RAP INCREMENTS 111111111100000000000000000000000000000000000  AT TIMF   54.00  MIN WITH THE SAME PROFILE @  0.0001750
```

```
THE TIME IS  54.000  MIN
   0.21 % PEN =  0.148E-02 KG/SEC FOR  0.586E+01 KG ACCUM PEN AND  0.181E-02 KG/SEC AVG PEN


THE TIME IS  59.323  MIN
   0.25 % PEN =  0.172E-02 KG/SEC FOR  0.641E+01 KG ACCUM PEN AND  0.180E-02 KG/SEC AVG PEN

 OP=  8.581E+00        3.817E-01        8.930E+00-------------- % ------------- 7.992E+00        3.753E-01        8.337E+00


END OF RAP

CUMULATIVE PENETRATION =    0.26 %

TOTAL PENETRATION FOR THIS PUFF = 0.548E+00 KG



RAP INCREMENTS 1111111111222222222200000000000000000000000000  AT TIME   60.00  MIN WITH THE SAME PROFILE @  0.0001750


THE TIME IS  60.000  MIN
   0.21 % PEN =  0.148E-02 KG/SEC FOR  0.647E+01 KG ACCUM PEN AND  0.180E-02 KG/SEC AVG PEN


THE TIME IS  65.287  MIN
   0.31 % PEN =  0.215E-02 KG/SEC FOR  0.715E+01 KG ACCUM PEN AND  0.182E-02 KG/SEC AVG PEN

 OP=  8.581E+00        8.075E-01        9.319E+00-------------- % ------------- 7.992E+00        7.999E-01        8.728E+00


END OF RAP

CUMULATIVE PENETRATION =    0.26 %

TOTAL PENETRATION FOR THIS PUFF = 0.679E+00 KG



RAP INCREMENTS 0000000000000000000033333333330000000000000000  AT TIME   66.00  MIN WITH THE SAME PROFILE @  0.0001750


THE TIME IS  66.000  MIN
   0.21 % PEN =  0.148E-02 KG/SEC FOR  0.721E+01 KG ACCUM PEN AND  0.182E-02 KG/SEC AVG PEN


THE TIME IS  71.250  MIN
   1.36 % PEN =  0.951E-02 KG/SEC FOR  0.102E+02 KG ACCUM PEN AND  0.239E-02 KG/SEC AVG PEN

 OP=  8.581E+00        5.447E+00        1.356E+01-------------- % ------------- 7.992E+00        5.432E+00        1.299E+01


END OF RAP

CUMULATIVE PENETRATION =    0.34 %

TOTAL PENETRATION FOR THIS PUFF = 0.300E+01 KG



FINAL STATISTICS FOR THIS CYCLE
```

```
 DIAM UM   AVG PEN %
   0.20       3.220
   0.40       5.795
   0.70       5.476
   1.10       4.071
   1.60       2.758
   2.50       1.480
   3.50       1.107
   4.50       1.646
   6.00       1.752
   8.50       1.199
  12.50       0.456
  20.00       0.052
  27.50       0.001
TOTAL PENETRATION FOR THIS CYCLE =  0.102E+02 KG

AVERAGE PERCENT PENETRATION =     0.34 %
```

APPENDIX F

OUTPUT DATA FROM EXAMPLE 6

```
*************************************
*                                   *
*          E.P.A. ESP MODEL         *
*                                   *
*    I.E.R.L.-R.T.P. AND SO.R.I.    *
*                                   *
*           REVISION III            *
*                                   *
*************************************


EPRI/SRI 1982 CORRELATION OF COLD SIDE ESP OPERATING POINTS

EPRI CONTRACT RP629-5     DR. R. A. ALTMAN, PROJECT MANAGER

INPUT DATA:   RESISTIVITY           =   1.00E+12 OHM-CM

              WIRE-TO-PLATE SPACING =  11.43 CM


V-I CURVE DATA FOR SECTION 1

   KILOVOLTS:  30.21 32.82 35.65 37.41 39.27 40.64 42.06 43.19 45.33 46.91

   NA/CM2:      1.00  2.00  4.00  6.00  9.00 12.00 16.00 20.00 30.00 40.00

   UA/FT2:      0.93  1.86  3.72  5.57  8.36 11.15 14.86 18.58 27.87 37.16

THE OPERATING POINT FOR SECTION 1 IS:

   KILOVOLTS:   34.09
   NA/CM2:       2.75
   UA/FT2:       2.56


V-I CURVE DATA FOR SECTION 2

   KILOVOLTS:  28.40 30.77 33.33 34.93 36.61 37.85 39.12 40.15 42.07 43.49

   NA/CM2:      1.00  2.00  4.00  6.00  9.00 12.00 16.00 20.00 30.00 40.00

   UA/FT2:      0.93  1.86  3.72  5.57  8.36 11.15 14.86 18.58 27.87 37.16

THE OPERATING POINT FOR SECTION 2 IS:

   KILOVOLTS:   33.16
   NA/CM2:        3.82
   UA/FT2:        3.55

V-I CURVE DATA FOR SECTION 3

   KILOVOLTS:  26.80 29.05 31.50 33.03 34.62 35.81 37.03 38.00 39.84 41.20

   NA/CM2:      1.00  2.00  4.00  6.00  9.00 12.00 16.00 20.00 30.00 40.00

   UA/FT2:      0.93  1.86  3.72  5.57  8.36 11.15 14.86 18.58 27.87 37.16

THE OPERATING POINT FOR SECTION 3 IS:

   KILOVOLTS:   33.32
   NA/CM2:       6.47
   UA/FT2:       6.01

V-I CURVE DATA FOR SECTION 4

   KILOVOLTS:  23.43 25.69 28.17 29.73 31.38 32.60 33.87 34.90 36.83 38.26

   NA/CM2:      1.00  2.00  4.00  6.00  9.00 12.00 16.00 20.00 30.00 40.00

   UA/FT2:      0.93  1.86  3.72  5.57  8.36 11.15 14.86 18.58 27.87 37.16

THE OPERATING POINT FOR SECTION 4 IS:

   KILOVOLTS:   30.98
   NA/CM2:       8.17
   UA/FT2:       7.59

V-I CURVE DATA FOR SECTION 5

   KILOVOLTS:  23.62 25.30 27.10 28.21 29.37 30.22 31.09 31.79 33.09 34.05

   NA/CM2:      1.00  2.00  4.00  6.00  9.00 12.00 16.00 20.00 30.00 40.00

   UA/FT2:      0.93  1.86  3.72  5.57  8.36 11.15 14.86 18.58 27.87 37.16

THE OPERATING POINT FOR SECTION 5 IS:
  KILOVOLTS:   30.90
  NA/CM2:      15.00
  UA/FT2:      13.94


V-I CURVE DATA FOR SECTION 6

  KILOVOLTS:  23.62 25.30 27.10 28.21 29.37 30.22 31.09 31.79 33.09 34.05

  NA/CM2:      1.00  2.00  4.00  6.00  9.00 12.00 16.00 20.00 30.00 40.00

  UA/FT2:      0.93  1.86  3.72  5.57  8.36 11.15 14.86 18.58 27.87 37.16

THE OPERATING POINT FOR SECTION 6 IS:

  KILOVOLTS:   30.90
  NA/CM2:      15.00
  UA/FT2:      13.94
```

```
*************************************
*                                   *
*          E.P.A. ESP MODEL         *
*     I.E.R.L.-R.T.P. AND SO.R.I.   *
*            REVISION III           *
*                                   *
*************************************

PRINTOUT OF INPUT DATA FOR DATA SET NUMBER  1


DATA ON CARD NUMBER   1

NENDPT = 17   NDATA =  1   NRAP =  0   MODL =  2   NOPRNT =  2   PATHL =  0.00 FT   NCOMPS =  0   NWAVES =  0  NLAMDA =  0

DATA ON CARD NUMBER   2

 SCA = 200

DATA ON CARD NUMBER   3

NEST =  2  NDIST =  2  NVI =  1  NX = 10  NY = 10  NITER =  2  NCALC =  1  NRAPD =  1  NEFF =  1  NTEMP =  1  NONID =  2

DATA ON CARD NUMBER   4

DL =  4.01000 GRN/ACF  PL =  18.0000 FT  ETAO = 98.50000 %  RD =  2270.00 KG/M**3  EPS =  1.000E+02
VRATIO =   1.2000  US =  .000220 M**2/V-SEC  FPATH =   1.0000  EBD = 1500000. V/M  RHOCGS =  1.00E+12 OHM-CM

DATA ON CARD NUMBER   5

ASNUCK( 1) =  .00  AZIGGY( 1) =  .00  AZNUMS( 1) =  2.0
ASNUCK( 2) =  .10  AZIGGY( 2) =  .25  AZNUMS( 2) =  2.0


DATA ON CARD NUMBER   6

ENDPT( 1) =    0.075 UM   ENDPT( 2) =    0.125 UM   ENDPT( 3) =    0.175 UM   ENDPT( 4) =    0.225 UM   ENDPT( 5) =    0.375 UM
ENDPT( 6) =    0.625 UM   ENDPT( 7) =    0.975 UM   ENDPT( 8) =    1.425 UM   ENDPT( 9) =    1.975 UM   ENDPT(10) =    3.025 UM


DATA ON CARD NUMBER   7
```

```
ENDPT(11) =    3.975 UM   ENDPT(12) =    5.025 UM   ENDPT(13) =    6.975 UM   ENDPT(14) =   10.025 UM   ENDPT(15) =   14.975 UM

ENDPT(16) =   25.025 UM   ENDPT(17) =   29.975 UM

DATA ON CARD NUMBER   8

D50 =  15.0000 UM  SIGMAP =   3.0000

DATA ON CARD NUMBER   9

NUMSEC =  2    LSECT( 1) = 10  LSECT( 2) = 10

DATA ON CARD NUMBER  10

AS( 1) =  2.0000E+04 FT**2  VOS( 1) =  3.4089E+04 V  TCS( 1) =  5.1104E-02 A  WLS( 1) =  5.2000E+04 FT

ACS( 1) =  5.3000E-02 IN  BS( 1) =  4.5000E+00 IN  NWS( 1) =  1.2000E+01

DATA ON CARD NUMBER  11

SYS( 1) =  4.5000E+00 IN  VGS( 1) =  2.0000E+05 FT**3/MIN  VGASS( 1) =  4.0000E+00 FT/SEC  TEMPS( 1) =  3.0000E+02 F

PS( 1) =  1.0000E+00 ATM  VISS( 1) =  2.2000E-05 KG/M-SEC  LINCS( 1) =  9.0000E-01 FT

DATA ON CARD NUMBER  12

AS( 2) =  2.0000E+04 FT**2  VOS( 2) =  3.3158E+04 V  TCS( 2) =  7.1000E-02 A  WLS( 2) =  5.2000E+04 FT

ACS( 2) =  5.3000E-02 IN  BS( 2) =  4.5000E+00 IN  NWS( 2) =  1.2000E+01

DATA ON CARD NUMBER  13

SYS( 2) =  4.5000E+00 IN  VGS( 2) =  2.0000E+05 FT**3/MIN  VGASS( 2) =  4.0000E+00 FT/SEC  TEMPS( 2) =  3.0000E+02 F

PS( 2) =  1.0000E+00 ATM  VISS( 2) =  2.2000E-05 KG/M-SEC  LINCS( 2) =  9.0000E-01 FT
```

```
EST. EFFICIENCY = 98.50     UNCORRECTED COMPUTED EFFICIENCY = 97.61
F[illegible] EFFICIENCY = 97.41     COMPUTED EFFICIENCY = 97.60     CONVERGES
```

```
PARTICLE SIZE RANGE STATISTICS

CORRECTIONS FOR NON-IDEAL CONDITIONS USING SET NO.  1 OF CORRECTION PARAMETERS

 PARTICLE     CCF    INLET %    OUTLET %    CORRECTED     NO-RAP      NO-RAP     NO-RAP   CORRECTED   CORRECTED   CORRECTED
 DIAMETER            IN BAND    IN BAND     OUTLET %    EFFICIENCY   MIG. VEL.    PEN.    EFFICIENCY   MIG. VEL.  PENETRATION

1.000E-07    3.360    0.001      0.0045      0.0033      87.9516      5.382    12.0484    84.3495      5.064      13.6505
1.500E-07    2.511    0.002      0.0210      0.0153      82.4260      4.422    17.5740    80.3940      4.143      19.6060
2.000E-07    2.099    0.004      0.0512      0.0373      80.0472      4.099    19.9528    77.7002      3.816      22.2998
3.000E-07    1.706    0.033      0.4823      0.3513      76.6935      3.704    23.3065    73.9212      3.418      26.0788
5.000E-07    1.411    0.152      2.2629      1.6667      76.4259      3.675    23.5741    73.3276      3.361      26.6724
8.000E-07    1.254    0.451      5.8829      4.4193      79.4114      4.019    20.5886    76.2414      3.655      23.7586
1.200E-06    1.149    0.965     10.1437      7.8128      83.3953      4.566    16.6047    80.3537      4.138      19.6463
1.700E-06    1.120    1.641     13.5051     10.6864      86.9995      5.188    13.0005    84.1975      4.692      15.8025
2.500E-06    1.081    4.002     23.2436     19.1375      90.8247      6.074     9.1753    88.3952      5.477      11.6048
3.500E-06    1.058    4.087     16.4946     14.1994      93.6239      7.000     6.3761    91.5683      6.289       8.4317
4.500E-06    1.045    4.639     13.8463     12.3881      95.2851      7.767     4.7149    93.5199      6.959       6.4801
6.000E-06    1.034    8.315     10.3397     11.6870      98.0356      9.994     1.9644    96.5893      8.591       3.4107
8.500E-06    1.024   11.398      3.3115      7.2890      99.5411     13.692     0.4589    98.4482     10.594       1.5518
1.250E-05    1.016   14.252      0.4075      4.7528      99.9548     19.587     0.0452    99.1907     12.249       0.8093
2.000E-05    1.010   17.996      0.0011      3.4747      99.9999     42.713     0.0001    99.5315     13.639       0.4685
2.750E-05    1.007   32.062      0.0020      2.0791      99.9999     58.115     0.0001    99.8426     16.413       0.1574.

EFFICIENCIES FOR CONVERGENCE CHECK:  STATED OR PREVIOUS CALCULATION =  97.608   FINAL CALCULATION =  97.604

  MMD OF INLET SIZE DISTRIBUTION    = 15.00
  SIGMAP OF INLET SIZE DISTRIBUTION =  3.00
  GAS VELOCITY SIGMAG = 0.00
  SNEAKAGE FRACTION   = 0.00
  NO. BAFFLED STAGES  = 2.
  NTEMP = 1
  RAPPING MMD   =  6.00
  RAPPING SIGMA =  2.50

  ADJUSTED NO-RAP EFF. =  98.4202
  MMD OF EFFLUENT UNDER NO-RAP CONDITIONS    = 2.44
  SIGMAP OF EFFLUENT UNDER NO-RAP CONDITIONS = 2.09
  QUALITY OF LOG-NORMAL FIT =  .997
  PRECIPITATION RATE PARAMETER UNDER NO-RAP CONDITIONS = 10.548

  EFF. CORRECTED FOR RAPPING =  97.5733
  CORRECTED MMD OF EFFLUENT    = 3.56
  CORRECTED SIGMAP OF EFFLUENT = 2.35
  QUALITY OF LOG-NORMAL FIT =  .999
  CORRECTED PRECIPITATION RATE PARAMETER =    9.46
```

UNADJUSTED MIGRATION VELOCITIES AND EFFICIENCIES, AND DISCRETE OUTLET MASS LOADINGS

PARTICLE DIAM. (M)	IDEAL UNADJUSTED MIG. VEL. (CM/SEC)	IDEAL UNADJUSTED EFFICIENCY (%)	NO-RAP DM/DLOGD (MG/DSCM)	RAPPING PUFF DM/DLOGD (MG/DSCM)	NO-RAP+RAP PUFF DM/DLOGD (MG/DSCM)	RAPPING PUFF DISTRIBUTION (%)
1.000E-07	2.215E+00	5.814E+01	4.524E-02	6.016E-03	5.126E-02	1.109E-03
1.500E-07	1.820E+00	5.111E+01	3.226E-01	3.730E-02	3.599E-01	4.529E-03
2.000E-07	1.687E+00	4.848E+01	1.053E+00	1.239E-01	1.177E+00	1.123E-02
3.000E-07	1.653E+00	4.781E+01	4.881E+00	5.805E-01	5.461E+00	1.070E-01
5.000E-07	1.837E+00	5.145E+01	2.290E+01	3.009E+00	2.591E+01	5.547E-01
8.000E-07	2.245E+00	5.864E+01	6.838E+01	1.053E+01	7.891E+01	1.689E+00
1.200E-06	2.834E+00	6.719E+01	1.382E+02	2.531E+01	1.635E+02	3.465E+00
1.700E-06	3.583E+00	7.556E+01	2.139E+02	4.610E+01	2.600E+02	5.429E+00
2.500E-06	4.783E+00	8.475E+01	2.818E+02	7.462E+01	3.564E+02	1.148E+01
3.500E-06	6.278E+00	9.153E+01	3.122E+02	1.007E+02	4.128E+02	9.918E+00
4.500E-06	7.767E+00	9.529E+01	3.053E+02	1.143E+02	4.197E+02	9.668E+00
6.000E-06	9.994E+00	9.804E+01	1.630E+02	1.200E+02	2.830E+02	1.420E+01
8.500E-06	1.369E+01	9.954E+01	4.719E+01	1.124E+02	1.596E+02	1.471E+01
1.250E-05	1.959E+01	9.995E+01	5.249E+00	8.880E+01	9.405E+01	1.286E+01
2.000E-05	4.271E+01	1.000E+02	1.148E-02	5.373E+01	5.374E+01	9.955E+00
2.750E-05	5.811E+01	1.000E+02	5.820E-02	9.147E+01	9.153E+01	5.957E+00

```
                              E.P.A. ESP MODEL
                          I.E.R.L.-R.T.P. AND SO.R.I.

                        SUMMARY TABLE OF ESP OPERATING
                          PARAMETERS AND PERFORMANCE


                              DATA SET NUMBER   1

                       NON-IDEAL CONDITION SET NUMBER  1

 ESP PERFORMANCE:          PENETRATION =   2.4 %

                           EFFICIENCY  =  97.6 %

                           SCA         =  39.3 M2/(M3/SEC)  = 200. FT2/(1000 ACFM)


 ELECTRICAL CONDITIONS:    AVG. APPLIED VOLTAGE =  33.6 KV

                           AVG. CURRENT DENSITY =   3.3 MA/CM2

                           FLY ASH RESISTIVITY  =   1.0E+12 OHM-CM


 SIZE DISTRIBUTIONS:       INLET MMD  = 15.0 UM    INLET SIGMAP  =  3.0

                           OUTLET MMD =  3.6 UM    OUTLET SIGMAP =  2.3


 NON-IDEAL CONDITIONS:     GAS SNEAKAGE FRACTION = 0.00    RAPPING MMD    =  6.0 UM

                           GAS VELOCITY SIGMAG   = 0.00    RAPPING SIGMAP =  2.5
```

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PARTICLE SIZE RANGE STATISTICS

CORRECTIONS FOR NON-IDEAL CONDITIONS USING SET NO.  2 OF CORRECTION PARAMETERS

 PARTICLE    CCF    INLET %   OUTLET %     CORRECTED     NO-RAP      NO-RAP       NO-RAP  CORRECTED   CORRECTED    CORRECTED
 DIAMETER           IN BAND   IN BAND      OUTLET %    EFFICIENCY   MIG. VEL.      PEN.  EFFICIENCY   MIG. VEL.   PENETRATION

1.000E-07   3.360    0.001     0.0024        0.0021      82.8476       4.483    17.1524    80.5666       4.166       19.4334
1.500E-07   2.511    0.002     0.0105        0.0091      76.9157       3.728    23.0843    74.0226       3.428       25.9774
2.000E-07   2.099    0.004     0.0249        0.0218      74.4527       3.470    25.5473    71.1111       3.158       28.8889
3.000E-07   1.706    0.033     0.2287        0.2013      70.8990       3.139    29.1010    66.9519       2.816       33.0481
5.000E-07   1.411    0.152     1.0785        0.9608      70.4088       3.097    29.5912    65.9977       2.743       34.0023
8.000E-07   1.254    0.451     2.9115        2.6368      73.1649       3.345    26.8351    68.6516       2.950       31.3484
1.200E-06   1.169    0.965     5.3375        4.9168      76.9893       3.736    23.0107    72.6589       3.298       27.3411
1.700E-06   1.120    1.641     7.6889        7.1810      80.5069       4.158    19.4931    76.5175       3.685       23.4825
2.500E-06   1.081    4.002    15.0754       14.2671      84.3273       4.713    15.6727    80.8683       4.206       19.1317
3.500E-06   1.058    4.087    12.6448       12.0321      87.1270       5.213    12.8730    84.2003       4.692       15.7997
4.500E-06   1.045    4.639    12.6139       11.9519      88.6879       5.542    11.3121    86.1747       5.032       13.8253
6.000E-06   1.034    8.315    14.6352       14.5372      92.6775       6.648     7.3225    90.6182       6.018        9.3818
8.500E-06   1.024   11.398    11.9332       12.5565      95.6443       7.969     4.3557    94.0883       7.192        5.9117
1.250E-05   1.016   14.252    10.1665       10.7711      97.0321       8.945     2.9679    95.9441       8.150        4.0559
2.000E-05   1.010   17.996     3.1357        4.6681      99.2751      12.529     0.7249    98.6080      10.870        1.3920
2.750E-05   1.007   32.062     2.5124        3.2864      99.6740      14.561     0.3260    99.4499      13.231        0.5501

EFFICIENCIES FOR CONVERGENCE CHECK:  STATED OR PREVIOUS CALCULATION =  97.608   FINAL CALCULATION =  97.604

    MMD OF INLET SIZE DISTRIBUTION     = 15.00
    SIGMAP OF INLET SIZE DISTRIBUTION =  3.00
    GAS VELOCITY SIGMAG = 0.25
    SNEAKAGE FRACTION   = 0.10
    NO. BAFFLED STAGES  = 2.
    NTEMP = 1
    RAPPING MMD   =  6.00
    RAPPING SIGMA =  2.50

    ADJUSTED NO-RAP EFF. =  95.8395
    MMD OF EFFLUENT UNDER NO-RAP CONDITIONS    = 4.28
    SIGMAP OF EFFLUENT UNDER NO-RAP CONDITIONS = 2.38
    QUALITY OF LOG-NORMAL FIT = 1.000
    PRECIPITATION RATE PARAMETER UNDER NO-RAP CONDITIONS =  8.086

    EFF. CORRECTED FOR RAPPING =  94.6335
    CORRECTED MMD OF EFFLUENT    = 4.64
    CORRECTED SIGMAP OF EFFLUENT = 2.42
    QUALITY OF LOG-NORMAL FIT = 1.000
    CORRECTED PRECIPITATION RATE PARAMETER =    7.44
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UNADJUSTED MIGRATION VELOCITIES AND EFFICIENCIES, AND DISCRETE OUTLET MASS LOADINGS

PARTICLE DIAM. (M)	IDEAL UNADJUSTED MIG. VEL. (CM/SEC)	IDEAL UNADJUSTED EFFICIENCY (%)	NO-RAP DM/DLOGD (MG/DSCM)	RAPPING PUFF DM/DLOGD (MG/DSCM)	NO-RAP+RAP PUFF DM/DLOGD (MG/DSCM)	RAPPING PUFF DISTRIBUTION (%)
1.000E-07	2.215E+00	5.814E+01	6.441E-02	8.566E-03	7.298E-02	1.109E-03
1.500E-07	1.820E+00	5.111E+01	4.238E-01	5.311E-02	4.769E-01	4.529E-03
2.000E-07	1.687E+00	4.848E+01	1.349E+00	1.764E-01	1.525E+00	1.123E-02
3.000E-07	1.653E+00	4.781E+01	6.094E+00	8.265E-01	6.920E+00	1.070E-01
5.000E-07	1.837E+00	5.145E+01	2.874E+01	4.285E+00	3.303E+01	5.547E-01
8.000E-07	2.245E+00	5.864E+01	8.913E+01	1.499E+01	1.041E+02	1.689E+00
1.200E-06	2.834E+00	6.719E+01	1.915E+02	3.603E+01	2.275E+02	3.465E+00
1.700E-06	3.583E+00	7.556E+01	3.207E+02	6.563E+01	3.863E+02	5.429E+00
2.500E-06	4.783E+00	8.475E+01	4.814E+02	1.062E+02	5.876E+02	1.148E+01
3.500E-06	6.278E+00	9.153E+01	6.303E+02	1.433E+02	7.736E+02	9.918E+00
4.500E-06	7.767E+00	9.529E+01	7.326E+02	1.628E+02	8.954E+02	9.668E+00
6.000E-06	9.994E+00	9.804E+01	6.076E+02	1.709E+02	7.785E+02	1.420E+01
8.500E-06	1.369E+01	9.954E+01	4.478E+02	1.600E+02	6.078E+02	1.471E+01
1.250E-05	1.959E+01	9.995E+01	3.449E+02	1.264E+02	4.713E+02	1.286E+01
2.000E-05	4.271E+01	1.000E+02	8.313E+01	7.650E+01	1.596E+02	9.955E+00
2.750E-05	5.811E+01	1.000E+02	1.895E+02	1.302E+02	3.197E+02	5.957E+00

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                              E.P.A. ESP MODEL
                          I.E.R.L.-R.T.P. AND SO.R.I.

                        SUMMARY TABLE OF ESP OPERATING
                          PARAMETERS AND PERFORMANCE


                              DATA SET NUMBER   1

                        NON-IDEAL CONDITION SET NUMBER  2

   ESP PERFORMANCE:          PENETRATION =   5.4 %

                             EFFICIENCY  =  94.6 %

                             SCA         =  39.3 M2/(M3/SEC)  = 200. FT2/(1000 ACFM)


   ELECTRICAL CONDITIONS:    AVG. APPLIED VOLTAGE =  33.6 KV

                             AVG. CURRENT DENSITY =   3.3 NA/CM2

                             FLY ASH RESISTIVITY  =   1.0E+12 OHM-CM


   SIZE DISTRIBUTIONS:       INLET MMD  = 15.0 UM    INLET SIGMAP  =  3.0

                             OUTLET MMD =  4.6 UM    OUTLET SIGMAP =  2.4


   NON-IDEAL CONDITIONS:     GAS SNEAKAGE FRACTION = 0.10    RAPPING MMD    =  6.0 UM

                             GAS VELOCITY SIGMAG   = 0.25    RAPPING SIGMAP =  2.5
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*                                     *
*          E.P.A. ESP MODEL           *
*     I.E.R.L.-R.T.P. AND SO.R.I.     *
*           REVISION III              *
*                                     *
***************************************

PRINTOUT OF INPUT DATA FOR DATA SET NUMBER  2


DATA ON CARD NUMBER   1

NENDPT = 17   NDATA =  1   NRAP =  0   MODL =  2   NOPRNT =  2   PATHL =  0.00 FT   NCOMPS =  0   NWAVES =  0  NLAMDA =  0

DATA ON CARD NUMBER   2

 SCA = 400

DATA ON CARD NUMBER   3

NEST =  2  NDIST =  2  NVI =  1  NX = 10  NY = 10  NITER =  2  NCALC =  1  NRAPD =  1  NEFF =  1  NTEMP =  1  NONID =  2

DATA ON CARD NUMBER   4

DL =  4.01000 GRN/ACF  PL =  36.0000 FT  ETAO = 98.50000 %  DD =  2270.00 KG/M**3  EPS =  1.000E+02
VRATIO =   1.2000  US =  .000220 M**2/V-SEC  FPATH =   1.0000  EBD = 1500000. V/M  RHOCGS =  1.00E+12 OHM-CM

DATA ON CARD NUMBER   5

ASNUCK( 1) =  .00  AZIGGY( 1) =  .00  AZNUMS( 1) =  4.0
ASNUCK( 2) =  .10  AZIGGY( 2) =  .25  AZNUMS( 2) =  4.0


DATA ON CARD NUMBER   6

ENDPT( 1) =    0.075 UM   ENDPT( 2) =    0.125 UM   ENDPT( 3) =    0.175 UM   ENDPT( 4) =    0.225 UM   ENDPT( 5) =    0.375 UM
ENDPT( 6) =    0.625 UM   ENDPT( 7) =    0.975 UM   ENDPT( 8) =    1.425 UM   ENDPT( 9) =    1.975 UM   ENDPT(10) =    3.025 UM


DATA ON CARD NUMBER   7
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```
ENDPT(11) =    3.975 UM   ENDPT(12) =    5.025 UM   ENDPT(13) =    6.975 UM   ENDPT(14) =   10.025 UM   ENDPT(15) =   14.975 UM
ENDPT(16) =   25.025 UM   ENDPT(17) =   29.975 UM

DATA ON CARD NUMBER   8

D50 =  15.0000 UM  SIGMAP =   3.0000

DATA ON CARD NUMBER   9

NUMSEC =  4    LSECT( 1) = 10  LSECT( 2) = 10  LSECT( 3) = 10  LSECT( 4) = 10

DATA ON CARD NUMBER  10

AS( 1) =  2.0000E+04 FT**2  VOS( 1) =  3.4089E+04 V  TCS( 1) =  5.1104E-02 A  WLS( 1) =  5.2000E+04 FT
ACS( 1) =  5.3000E-02 IN  BS( 1) =  4.5000E+00 IN  NWS( 1) =  1.2000E+01

DATA ON CARD NUMBER  11

SYS( 1) =  4.5000E+00 IN  VGS( 1) =  2.0000E+05 FT**3/MIN  VGASS( 1) =  4.0000E+00 FT/SEC  TEMPS( 1) =  3.0000E+02 F
PS( 1) =  1.0000E+00 ATM  VISS( 1) =  2.2000E-05 KG/M-SEC  LINCS( 1) =  9.0000E-01 FT

DATA ON CARD NUMBER  12

AS( 2) =  2.0000E+04 FT**2  VOS( 2) =  3.3158E+04 V  TCS( 2) =  7.1000E-02 A  WLS( 2) =  5.2000E+04 FT
ACS( 2) =  5.3000E-02 IN  BS( 2) =  4.5000E+00 IN  NWS( 2) =  1.2000E+01

DATA ON CARD NUMBER  13

SYS( 2) =  4.5000E+00 IN  VGS( 2) =  2.0000E+05 FT**3/MIN  VGASS( 2) =  4.0000E+00 FT/SEC  TEMPS( 2) =  3.0000E+02 F
PS( 2) =  1.0000E+00 ATM  VISS( 2) =  2.2000E-05 KG/M-SEC  LINCS( 2) =  9.0000E-01 FT

DATA ON CARD NUMBER  14

AS( 3) =  2.0000E+04 FT**2  VOS( 3) =  3.3318E+04 V  TCS( 3) =  1.2024E-01 A  WLS( 3) =  5.2000E+04 FT
ACS( 3) =  5.3000E-02 IN  BS( 3) =  4.5000E+00 IN  NWS( 3) =  1.2000E+01

DATA ON CARD NUMBER  15
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```
SYS( 3) =  4.5000E+00 IN  VGS( 3) =  2.0000E+05 FT**3/MIN  VGASS( 3) =  4.0000E+00 FT/SEC  TEMPS( 3) =  3.0000E+02 F

PS( 3) =  1.0000E+00 ATM  VISS( 3) =  2.2000E-05 KG/M-SEC  LINCS( 3) =  9.0000E-01 FT

DATA ON CARD NUMBER  16

AS( 4) =  2.0000E+04 FT**2  VOS( 4) =  3.0976E+04 V  TCS( 4) =  1.5172E-01 A  WLS( 4) =  5.2000E+04 FT

ACS( 4) =  5.3000E-02 IN  DS( 4) =  4.5000E+00 IN  NWS( 4) =  1.2000E+01

DATA ON CARD NUMBER  17

SYS( 4) =  4.5000E+00 IN  VGS( 4) =  2.0000E+05 FT**3/MIN  VGASS( 4) =  4.0000E+00 FT/SEC  TEMPS( 4) =  3.0000E+02 F

PS( 4) =  1.0000E+00 ATM  VISS( 4) =  2.2000E-05 KG/M-SEC  LINCS( 4) =  9.0000E-01 FT
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                              E.P.A. ESP MODEL
                          I.E.R.L.-R.T.P. AND SO.R.I.

                        SUMMARY TABLE OF ESP OPERATING
                          PARAMETERS AND PERFORMANCE


                              DATA SET NUMBER   2

                        NON-IDEAL CONDITION SET NUMBER  1

ESP PERFORMANCE:          PENETRATION =   0.090 %

                          EFFICIENCY  =  99.910 %

                          SCA         =  78.6 M2/(M3/SEC)  = 400. FT2/(1000 ACFM)


ELECTRICAL CONDITIONS:    AVG. APPLIED VOLTAGE =  32.9 KV

                          AVG. CURRENT DENSITY =   5.3 NA/CM2

                          FLY ASH RESISTIVITY  =   1.0E+12 OHM-CM


SIZE DISTRIBUTIONS:       INLET MMD  = 15.0 UM    INLET SIGMAP  =  3.0

                          OUTLET MMD =  3.0 UM    OUTLET SIGMAP =  2.4


NON-IDEAL CONDITIONS:     GAS SNEAKAGE FRACTION = 0.00    RAPPING MMD    =  6.0 UM

                          GAS VELOCITY SIGMAG   = 0.00    RAPPING SIGMAP =  2.5
```

```
                              E.P.A. ESP MODEL
                          I.E.R.L.-R.T.P. AND SO.R.I.

                        SUMMARY TABLE OF ESP OPERATING
                          PARAMETERS AND PERFORMANCE


                             DATA SET NUMBER   2

                        NON-IDEAL CONDITION SET NUMBER  2

ESP PERFORMANCE:          PENETRATION =   0.38 %

                          EFFICIENCY  =  99.62 %

                          SCA         =  78.6 M2/(M3/SEC)  = 400. FT2/(1000 ACFM)


ELECTRICAL CONDITIONS:    AVG. APPLIED VOLTAGE =  32.9 KV

                          AVG. CURRENT DENSITY =   5.3 NA/CM2

                          FLY ASH RESISTIVITY  =   1.0E+12 OHM-CM


SIZE DISTRIBUTIONS:       INLET MMD  = 15.0 UM    INLET SIGMAP  =  3.0

                          OUTLET MMD =  3.2 UM    OUTLET SIGMAP =  2.3


NON-IDEAL CONDITIONS:     GAS SNEAKAGE FRACTION = 0.10    RAPPING MMD    =  6.0 UM

                          GAS VELOCITY SIGMAG   = 0.25    RAPPING SIGMAP =  2.5
```

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                    **************************************
                    *                                    *
                    *          E.P.A. ESP MODEL          *
                    *                                    *
                    *    I.E.R.L.-R.T.P. AND SO.R.I.     *
                    *                                    *
                    *            REVISION III            *
                    *                                    *
                    **************************************

PRINTOUT OF INPUT DATA FOR DATA SET NUMBER  3


DATA ON CARD NUMBER   1

NENDPT = 17   NDATA =  1   NRAP =  0   MODL =  2   NOPRNT =  2   PATHL =  0.00 FT   NCOMPS =  0   NWAVES =  0  NLAMDA =  0

DATA ON CARD NUMBER   2

 SCA = 600

DATA ON CARD NUMBER   3

NEST =  2  NDIST =  2  NVI =  1  NX = 10  NY = 10  NITER =  2  NCALC =  1  NRAPD =  1  NEFF =  1  NTEMP =  1  NONID =  2

DATA ON CARD NUMBER   4

DL =  4.01000 GRN/ACF  PL =  54.0000 FT  ETAD = 98.50000 %  DD =  2270.00 KG/M**3  EPS =  1.000E+02
VRATIO =   1.2000  US =  .000220 M**2/V-SEC  FPATH =   1.0000  EBD = 1500000. V/M  RHOCGS =  1.00E+12 OHM-CM

DATA ON CARD NUMBER   5

ASNUCK( 1) =  .00  AZIGGY( 1) =  .00  AZNUMS( 1) =  6.0
ASNUCK( 2) =  .10  AZIGGY( 2) =  .25  AZNUMS( 2) =  6.0

DATA ON CARD NUMBER   6

ENDPT( 1) =    0.075 UM   ENDPT( 2) =    0.125 UM   ENDPT( 3) =    0.175 UM   ENDPT( 4) =    0.225 UM   ENDPT( 5) =    0.375 UM
ENDPT( 6) =    0.625 UM   ENDPT( 7) =    0.975 UM   ENDPT( 8) =    1.425 UM   ENDPT( 9) =    1.975 UM   ENDPT(10) =    3.025 UM

DATA ON CARD NUMBER   7
```

```
ENDPT(11) =    3.975 UM   ENDPT(12) =    5.025 UM   ENDPT(13) =    6.975 UM   ENDPT(14) =   10.025 UM   ENDPT(15) =   14.975 UM
ENDPT(16) =   25.025 UM   ENDPT(17) =   29.975 UM

DATA ON CARD NUMBER   8

D50 =  15.0000 UM  SIGMAP =   3.0000

DATA ON CARD NUMBER   9

NUMSEC =  6    LSECT( 1) = 10  LSECT( 2) = 10  LSECT( 3) = 10  LSECT( 4) = 10  LSECT( 5) = 10
LSECT( 6) = 10

DATA ON CARD NUMBER  10

AS( 1) =  2.0000E+04 FT**2  VOS( 1) =  3.4089E+04 V  TCS( 1) =  5.1104E-02 A  WLS( 1) =  5.2000E+04 FT
ACS( 1) =  5.3000E-02 IN  BS( 1) =  4.5000E+00 IN  NWS( 1) =  1.2000E+01

DATA ON CARD NUMBER  11

SYS( 1) =  4.5000E+00 IN  VGS( 1) =  2.0000E+05 FT**3/MIN  VGASS( 1) =  4.0000E+00 FT/SEC  TEMPS( 1) =  3.0000E+02 F
PS( 1) =  1.0000E+00 ATM  VISS( 1) =  2.2000E-05 KG/M-SEC  LINCS( 1) =  9.0000E-01 FT

DATA ON CARD NUMBER  12

AS( 2) =  2.0000E+04 FT**2  VOS( 2) =  3.3158E+04 V  TCS( 2) =  7.1000E-02 A  WLS( 2) =  5.2000E+04 FT
ACS( 2) =  5.3000E-02 IN  BS( 2) =  4.5000E+00 IN  NWS( 2) =  1.2000E+01

DATA ON CARD NUMBER  13

SYS( 2) =  4.5000E+00 IN  VGS( 2) =  2.0000E+05 FT**3/MIN  VGASS( 2) =  4.0000E+00 FT/SEC  TEMPS( 2) =  3.0000E+02 F
PS( 2) =  1.0000E+00 ATM  VISS( 2) =  2.2000E-05 KG/M-SEC  LINCS( 2) =  9.0000E-01 FT

DATA ON CARD NUMBER  14

AS( 3) =  2.0000E+04 FT**2  VOS( 3) =  3.3318E+04 V  TCS( 3) =  1.2024E-01 A  WLS( 3) =  5.2000E+04 FT
ACS( 3) =  5.3000E-02 IN  BS( 3) =  4.5000E+00 IN  NWS( 3) =  1.2000E+01

DATA ON CARD NUMBER  15
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```
SYS( 3) =  4.5000E+00 IN  VGS( 3) =  2.0000E+05 FT**3/MIN  VGASS( 3) =  4.0000E+00 FT/SEC  TEMPS( 3) =  3.0000E+02 F
PS( 3) =  1.0000E+00 ATM  VISS( 3) =  2.2000E-05 KG/M-SEC  LINCS( 3) =  9.0000E-01 FT

DATA ON CARD NUMBER  16

AS( 4) =  2.0000E+04 FT**2  VOS( 4) =  3.0976E+04 V  TCS( 4) =  1.5172E-01 A  WLS( 4) =  5.2000E+04 FT
ACS( 4) =  5.3000E-02 IN  BS( 4) =  4.5000E+00 IN  NWS( 4) =  1.2000E+01

DATA ON CARD NUMBER  17

SYS( 4) =  4.5000E+00 IN  VGS( 4) =  2.0000E+05 FT**3/MIN  VGASS( 4) =  4.0000E+00 FT/SEC  TEMPS( 4) =  3.0000E+02 F
PS( 4) =  1.0000E+00 ATM  VISS( 4) =  2.2000E-05 KG/M-SEC  LINCS( 4) =  9.0000E-01 FT

DATA ON CARD NUMBER  18

AS( 5) =  2.0000E+04 FT**2  VOS( 5) =  3.0897E+04 V  TCS( 5) =  2.7871E-01 A  WLS( 5) =  5.2000E+04 FT
ACS( 5) =  5.3000E-02 IN  BS( 5) =  4.5000E+00 IN  NWS( 5) =  1.2000E+01

DATA ON CARD NUMBER  19

SYS( 5) =  4.5000E+00 IN  VGS( 5) =  2.0000E+05 FT**3/MIN  VGASS( 5) =  4.0000E+00 FT/SEC  TEMPS( 5) =  3.0000E+02 F
PS( 5) =  1.0000E+00 ATM  VISS( 5) =  2.2000E-05 KG/M-SEC  LINCS( 5) =  9.0000E-01 FT

DATA ON CARD NUMBER  20

AS( 6) =  2.0000E+04 FT**2  VOS( 6) =  3.0897E+04 V  TCS( 6) =  2.7871E-01 A  WLS( 6) =  5.2000E+04 FT
ACS( 6) =  5.3000E-02 IN  BS( 6) =  4.5000E+00 IN  NWS( 6) =  1.2000E+01

DATA ON CARD NUMBER  21

SYS( 6) =  4.5000E+00 IN  VGS( 6) =  2.0000E+05 FT**3/MIN  VGASS( 6) =  4.0000E+00 FT/SEC  TEMPS( 6) =  3.0000E+02 F
PS( 6) =  1.0000E+00 ATM  VISS( 6) =  2.2000E-05 KG/M-SEC  LINCS( 6) =  9.0000E-01 FT
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                                 E.P.A. ESP MODEL
                           I.E.R.L.-R.T.P. AND SO.R.I.

                          SUMMARY TABLE OF ESP OPERATING
                            PARAMETERS AND PERFORMANCE


                               DATA SET NUMBER   3

                        NON-IDEAL CONDITION SET NUMBER  1

ESP PERFORMANCE:           PENETRATION =   0.006 %

                           EFFICIENCY  =  99.994 %

                           SCA         = 118.0 M2/(M3/SEC)  = 599. FT2/(1000 ACFM)


ELECTRICAL CONDITIONS:     AVG. APPLIED VOLTAGE =  32.2 KV

                           AVG. CURRENT DENSITY =   8.5 NA/CM2

                           FLY ASH RESISTIVITY  =   1.0E+12 OHM-CM


SIZE DISTRIBUTIONS:        INLET MMD  = 15.0 UM    INLET SIGMAP  =  3.0

                           OUTLET MMD =  2.8 UM    OUTLET SIGMAP =  2.4


NON-IDEAL CONDITIONS:      GAS SNEAKAGE FRACTION = 0.00    RAPPING MMD    =  6.0 UM

                           GAS VELOCITY SIGMAG   = 0.00    RAPPING SIGMAP =  2.5
                          E.P.A. ESP MODEL
                       I.E.R.L.-R.T.P. AND SO.R.I.

                     SUMMARY TABLE OF ESP OPERATING
                       PARAMETERS AND PERFORMANCE


                          DATA SET NUMBER   3

                    NON-IDEAL CONDITION SET NUMBER  2

ESP PERFORMANCE:         PENETRATION =   0.043 %

                         EFFICIENCY  =  99.957 %

                         SCA         = 118.0 M2/(M3/SEC)  = 599. FT2/(1000 ACFM)


ELECTRICAL CONDITIONS:   AVG. APPLIED VOLTAGE =  32.2 KV

                         AVG. CURRENT DENSITY =   8.5 NA/CM2

                         FLY ASH RESISTIVITY  =   1.0E+12 OHM-CM


SIZE DISTRIBUTIONS:      INLET MMD  = 15.0 UM    INLET SIGMAP  =  3.0

                         OUTLET MMD =  2.9 UM    OUTLET SIGMAP =  2.2


NON-IDEAL CONDITIONS:    GAS SNEAKAGE FRACTION = 0.10    RAPPING MMD    =  6.0 UM

                         GAS VELOCITY SIGMAG   = 0.25    RAPPING SIGMAP =  2.5
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                          ***********************************
                          *                                 *
                          *         E.P.A. ESP MODEL        *
                          *                                 *
                          *   I.E.R.L.-R.T.P. AND SO.R.I.   *
                          *                                 *
                          *           REVISION III          *
                          *                                 *
                          ***********************************

PRINTOUT OF INPUT DATA FOR DATA SET NUMBER  4


DATA ON CARD NUMBER   1

NENDPT = 17   NDATA =  1   NRAP =  0   MODL =  2   NOPRNT =  2   PATHL =  0.00 FT   NCOMPS =  0   NWAVES =  0  NLAMDA =  0

DATA ON CARD NUMBER   2

 SCA = 800

DATA ON CARD NUMBER   3

NEST =  2  NDIST =  2  NVI =  1  NX = 10  NY = 10  NITER =  2  NCALC =  1  NRAPD =  1  NEFF =  1  NTEMP =  1  NONID =  2

DATA ON CARD NUMBER   4

DL =  4.01000 GRN/ACF  PL =  72.0000 FT  ETAD = 98.50000 %  DD =  2270.00 KG/M**3  EPS =  1.000E+02
VRATIO =   1.2000  US =  .000220 M**2/V-SEC  FPATH =   1.0000  EBD = 1500000. V/M  RHOCOS =  1.00E+12 OHM-CM

DATA ON CARD NUMBER   5

ASNUCK( 1) =  .00  AZIGGY( 1) =  .00  AZNUMS( 1) =  6.0
ASNUCK( 2) =  .10  AZIGGY( 2) =  .25  AZNUMS( 2) =  6.0


DATA ON CARD NUMBER   6

ENDPT( 1) =    0.075 UM   ENDPT( 2) =    0.125 UM   ENDPT( 3) =    0.175 UM   ENDPT( 4) =    0.225 UM   ENDPT( 5) =    0.375 UM
ENDPT( 6) =    0.625 UM   ENDPT( 7) =    0.975 UM   ENDPT( 8) =    1.425 UM   ENDPT( 9) =    1.975 UM   ENDPT(10) =    3.025 UM


DATA ON CARD NUMBER   7
```

```
ENDPT(11) =    3.975 UM   ENDPT(12) =    5.025 UM   ENDPT(13) =    6.975 UM   ENDPT(14) =   10.025 UM   ENDPT(15) =   14.975 UM

ENDPT(16) =   25.025 UM   ENDPT(17) =   29.975 UM

DATA ON CARD NUMBER   8

D50 =  15.0000 UM  SIGMAP =   3.0000

DATA ON CARD NUMBER   9

NUMSEC =  6    LSECT( 1) = 10  LSECT( 2) = 10  LSECT( 3) = 10  LSECT( 4) = 10  LSECT( 5) = 10

LSECT( 6) = 10

DATA ON CARD NUMBER  10

AS( 1) =  2.0000E+04 FT**2  VOS( 1) =  3.4089E+04 V  TCS( 1) =  5.1104E-02 A  WLS( 1) =  5.2000E+04 FT

ACS( 1) =  5.3000E-02 IN  BS( 1) =  4.5000E+00 IN  NWS( 1) =  1.2000E+01

DATA ON CARD NUMBER  11

SYS( 1) =  6.0000E+00 IN  VGS( 1) =  1.5000E+05 FT**3/MIN  VGASS( 1) =  4.0000E+00 FT/SEC  TEMPS( 1) =  3.0000E+02 F

PS( 1) =  1.0000E+00 ATM  VISS( 1) =  2.2000E-05 KG/M-SEC  LINCS( 1) =  1.2000E+00 FT

DATA ON CARD NUMBER  12

AS( 2) =  2.0000E+04 FT**2  VOS( 2) =  3.3158E+04 V  TCS( 2) =  7.1000E-02 A  WLS( 2) =  5.2000E+04 FT

ACS( 2) =  5.3000E-02 IN  BS( 2) =  4.5000E+00 IN  NWS( 2) =  1.2000E+01

DATA ON CARD NUMBER  13

SYS( 2) =  6.0000E+00 IN  VGS( 2) =  1.5000E+05 FT**3/MIN  VGASS( 2) =  4.0000E+00 FT/SEC  TEMPS( 2) =  3.0000E+02 F

PS( 2) =  1.0000E+00 ATM  VISS( 2) =  2.2000E-05 KG/M-SEC  LINCS( 2) =  1.2000E+00 FT

DATA ON CARD NUMBER  14

AS( 3) =  2.0000E+04 FT**2  VOS( 3) =  3.3318E+04 V  TCS( 3) =  1.2024E-01 A  WLS( 3) =  5.2000E+04 FT

ACS( 3) =  5.3000E-02 IN  BS( 3) =  4.5000E+00 IN  NWS( 3) =  1.2000E+01

DATA ON CARD NUMBER  15
```

```
SYS( 3) =  6.0000E+00 IN  VGS( 3) =  1.5000E+05 FT**3/MIN  VGASS( 3) =  4.0000E+00 FT/SEC  TEMPS( 3) =  3.0000E+02 F

PS( 3) =  1.0000E+00 ATM  VISS( 3) =  2.2000E-05 KG/M-SEC  LINCS( 3) =  1.2000E+00 FT

DATA ON CARD NUMBER  16

AS( 4) =  2.0000E+04 FT**2  VOS( 4) =  3.0976E+04 V  TCS( 4) =  1.5172E-01 A  WLS( 4) =  5.2000E+04 FT

ACS( 4) =  5.3000E-02 IN  BS( 4) =  4.5000E+00 IN  NWS( 4) =  1.2000E+01

DATA ON CARD NUMBER  17

SYS( 4) =  6.0000E+00 IN  VGS( 4) =  1.5000E+05 FT**3/MIN  VGASS( 4) =  4.0000E+00 FT/SEC  TEMPS( 4) =  3.0000E+02 F

PS( 4) =  1.0000E+00 ATM  VISS( 4) =  2.2000E-05 KG/M-SEC  LINCS( 4) =  1.2000E+00 FT

DATA ON CARD NUMBER  18

AS( 5) =  2.0000E+04 FT**2  VOS( 5) =  3.0897E+04 V  TCS( 5) =  2.7871E-01 A  WLS( 5) =  5.2000E+04 FT

ACS( 5) =  5.3000E-02 IN  BS( 5) =  4.5000E+00 IN  NWS( 5) =  1.2000E+01

DATA ON CARD NUMBER  19

SYS( 5) =  6.0000E+00 IN  VGS( 5) =  1.5000E+05 FT**3/MIN  VGASS( 5) =  4.0000E+00 FT/SEC  TEMPS( 5) =  3.0000E+02 F

PS( 5) =  1.0000E+00 ATM  VISS( 5) =  2.2000E-05 KG/M-SEC  LINCS( 5) =  1.2000E+00 FT

DATA ON CARD NUMBER  20

AS( 6) =  2.0000E+04 FT**2  VOS( 6) =  3.0897E+04 V  TCS( 6) =  2.7871E-01 A  WLS( 6) =  5.2000E+04 FT

ACS( 6) =  5.3000E-02 IN  BS( 6) =  4.5000E+00 IN  NWS( 6) =  1.2000E+01

DATA ON CARD NUMBER  21

SYS( 6) =  6.0000E+00 IN  VGS( 6) =  1.5000E+05 FT**3/MIN  VGASS( 6) =  4.0000E+00 FT/SEC  TEMPS( 6) =  3.0000E+02 F

PS( 6) =  1.0000E+00 ATM  VISS( 6) =  2.2000E-05 KG/M-SEC  LINCS( 6) =  1.2000E+00 FT
```

```
*******************************************************************************************************************
*                                                                                                                 *
*                                                E.P.A. ESP MODEL                                                 *
*                                           I.E.R.L.-R.T.P. AND SO.R.I.                                           *
*                                                                                                                 *
*                                          SUMMARY TABLE OF ESP OPERATING                                         *
*                                            PARAMETERS AND PERFORMANCE                                           *
*                                                                                                                 *
*                                                                                                                 *
*                                               DATA SET NUMBER   4                                               *
*                                                                                                                 *
*                                        NON-IDEAL CONDITION SET NUMBER  1                                        *
*                                                                                                                 *
*                ESP PERFORMANCE:           PENETRATION =   0.001 %                                               *
*                                                                                                                 *
*                                           EFFICIENCY  =  99.999 %                                               *
*                                                                                                                 *
*                                           SCA         = 157.3 M2/(M3/SEC)  = 799. FT2/(1000 ACFM)               *
*                                                                                                                 *
*                                                                                                                 *
*                ELECTRICAL CONDITIONS:     AVG. APPLIED VOLTAGE =  32.2 KV                                       *
*                                                                                                                 *
*                                           AVG. CURRENT DENSITY =   8.5 NA/CM2                                   *
*                                                                                                                 *
*                                           FLY ASH RESISTIVITY  =   1.0E+12 OHM-CM                               *
*                                                                                                                 *
*                                                                                                                 *
*                SIZE DISTRIBUTIONS:        INLET MMD  = 15.0 UM    INLET SIGMAP  =  3.0                          *
*                                                                                                                 *
*                                           OUTLET MMD =  3.4 UM    OUTLET SIGMAP =  2.8                          *
*                                                                                                                 *
*                                                                                                                 *
*                NON-IDEAL CONDITIONS:      GAS SNEAKAGE FRACTION = 0.00    RAPPING MMD    =  6.0 UM              *
*                                                                                                                 *
*                                           GAS VELOCITY SIGMAG   = 0.00    RAPPING SIGMAP =  2.5                 *
*                                                                                                                 *
*******************************************************************************************************************
```

```
                         E.P.A. ESP MODEL
                      I.E.R.L.-R.T.P. AND SO.R.I.

                   SUMMARY TABLE OF ESP OPERATING
                     PARAMETERS AND PERFORMANCE


                         DATA SET NUMBER   4

                  NON-IDEAL CONDITION SET NUMBER  2

ESP PERFORMANCE:         PENETRATION =   0.009 %

                         EFFICIENCY  =  99.991 %

                         SCA         = 157.3 M2/(M3/SEC)  = 799. FT2/(1000 ACFM)


ELECTRICAL CONDITIONS:   AVG. APPLIED VOLTAGE =  32.2 KV

                         AVG. CURRENT DENSITY =   8.5 NA/CM2

                         FLY ASH RESISTIVITY  =   1.0E+12 OHM-CM


SIZE DISTRIBUTIONS:      INLET MMD  = 15.0 UM    INLET SIGMAP  =  3.0

                         OUTLET MMD =  3.1 UM    OUTLET SIGMAP =  2.3


NON-IDEAL CONDITIONS:    GAS SNEAKAGE FRACTION = 0.10    RAPPING MMD    =  6.0 UM

                         GAS VELOCITY SIGMAG   = 0.25    RAPPING SIGMAP =  2.5
```

APPENDIX G

OUTPUT DATA FROM EXAMPLE 7

```
                        ***********************************
                        *                                 *
                        *         E.P.A. ESP MODEL        *
                        *                                 *
                        *  I.E.R.L.-R.T.P. AND SO.R.I.    *
                        *                                 *
                        *          REVISION III           *
                        *                                 *
                        ***********************************

 PRINTOUT OF INPUT DATA FOR DATA SET NUMBER  1


>>>>> CHECK VALUE OF DL

>>>>> CHECK VALUE OF DD

>>>>> CHECK VALUE OF AS( 1)

>>>>> CHECK VALUE OF TEMPS( 1)

>>>>> CHECK VALUE OF AS( 2)

>>>>> CHECK VALUE OF TEMPS( 2)

>>>>> CHECK VALUE OF TEMPS( 3)

 DATA ON CARD NUMBER   1

 NENDPT = 14   NDATA =  1   NRAP =  0   NMODL =  0   NOPRNT =  0   PATHL =  0.00 FT   NCOMPS =  0   NWAVES =  0  NLAMDA =  0

 DATA ON CARD NUMBER   2

 LAB ESP: SCA=125FT2/1000ACFM;J=24UA/FT2;MMD=2UM;SIGMAP=2.5

 DATA ON CARD NUMBER   3

 NEST =  1  NDIST =  2  NVI =  1  NX = 10  NY = 10  NITER =  3  NCALC =  0  NRAPD =  1  NEFF =  1  NTEMP =  1  NUNID =  1

 DATA ON CARD NUMBER   4

 NN =  5

 DATA ON CARD NUMBER   5

 DL =  0.01500 GRN/ACF  PL =  10.0000 FT  ETAU = 99.00000 %  DD =   100.00 KG/M**3  EPS =  5.100E+00
```

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```
VRATIO =   1.0300  US =  .000165 M**2/V-SEC  FPATH =   1.0000  EOD = 1500000. V/M  RHOCGS =  1.00E+09 OHM-CM

DATA ON CARD NUMBER   6

ASNUCK( 1) =  .00  AZIGGY( 1) =  .00  AZNUMS( 1) =  4.0


DATA ON CARD NUMBER   7

ENDPT( 1) =    0.100 UM   ENDPT( 2) =    0.300 UM   ENDPT( 3) =    0.500 UM   ENDPT( 4) =    0.700 UM   ENDPT( 5) =    0.900 UM
ENDPT( 6) =    1.100 UM   ENDPT( 7) =    2.900 UM   ENDPT( 8) =    5.100 UM   ENDPT( 9) =    6.900 UM   ENDPT(10) =    9.100 UM


DATA ON CARD NUMBER   8

ENDPT(11) =   10.900 UM   ENDPT(12) =   19.100 UM   ENDPT(13) =   30.900 UM   ENDPT(14) =   49.100 UM

DATA ON CARD NUMBER   9

D50 =   2.0000 UM  SIGMAP =   2.5000

DATA ON CARD NUMBER  10

NUMSEC =  3    LSECT( 1) =  3  LSECT( 2) =  3  LSECT( 3) =  6

DATA ON CARD NUMBER  11

AS( 1) =  6.2500E+00 FT**2  VOS( 1) =  4.6000E+04 V  TCS( 1) =  1.5000E-04 A  WLS( 1) =  6.2500E+00 FT
ACS( 1) =  4.6875E-02 IN  BS( 1) =  5.0000E+00 IN  NWS( 1) =  5.0000E+00

DATA ON CARD NUMBER  12

SYS( 1) =  2.5000E+00 IN  VGS( 1) =  2.0000E+02 FT**3/MIN  VGASS( 1) =  3.2000E+00 FT/SEC  TEMPS( 1) =  7.6600E+01 F
PS( 1) =  1.0000E+00 ATM  VISS( 1) =  1.8000E-05 KG/M-SEC  LINCS( 1) =  8.3333E-01 FT

DATA ON CARD NUMBER  13

AS( 2) =  6.2500E+00 FT**2  VOS( 2) =  4.5800E+04 V  TCS( 2) =  1.5000E-04 A  WLS( 2) =  6.2500E+00 FT
ACS( 2) =  4.6875E-02 IN  BS( 2) =  5.0000E+00 IN  NWS( 2) =  5.0000E+00
```

```
DATA ON CARD NUMBER  14

SYS( 2) =  2,5000E+00 IN  VGS( 2) =  2.0000E+02 FT**3/MIN  VGASS( 2) =  3,2000E+00 FT/SEC  TEMPS( 2) =  7,6800E+01 F

PS( 2) =  1,0000E+00 ATM  VISS( 2) =  1.6000E-05 KG/M-SEC  LINCS( 2) =  8,3333E-01 FT

DATA ON CARD NUMBER  15

AS( 3) =  1,2500E+01 FT**2  VOS( 3) =  4,4400E+04 V  TCS( 3) =  3,0000E-04 A  WLS( 3) =  1,2500E+01 FT

ACS( 3) =  4,6875E-02 IN  BS( 3) =  5,0000E+00 IN  NWS( 3) =  1,0000E+01

DATA ON CARD NUMBER  16

SYS( 3) =  2,5000E+00 IN  VGS( 3) =  2.0000E+02 FT**3/MIN  VGASS( 3) =  3,2000E+00 FT/SEC  TEMPS( 3) =  7,6800E+01 F

PS( 3) =  1,0000E+00 ATM  VISS( 3) =  1.8000E-05 KG/M-SEC  LINCS( 3) =  8,3333E-01 FT
```

```
INCREMENTAL ANALYSIS OF PRECIPITATOR PERFORMANCE


LAB ESP: SCA=125FT2/1000ACFM;J=24UA/FT2;MMD=2UM;SIGMAP=2.5

CALCULATION IS IN SECTION NO. = 1 AND THE SECTION LENGTH IS =  0,7625 M

COLLECTION AREA =  5,813E-01 M2         APPLIED VOLTAGE =  4,600E+04 VOLTS        TOTAL CURRENT =  1,500E-04 AMPS
WIRE TO PLATE =  1,270E-01 M            CORONA WIRE RADIUS =  1,191E-03 M         CORONA WIRE LENGTH =  1,906E+00 M
CURRENT/M =  7,869E-05 AMP/M            CURRENT DENSITY =  2,581E-04 AMP/M2       DEPOSIT E FIELD =  2,581E+03 VOLT/M
1/2 WIRE TO WIRE =  6,350E-02 M         GAS FLOW RATE =  9,460E-02 M3/SEC         GAS VELOCITY =  9,760E-01 M/SEC
TEMPERATURE = 297,667 K                 PRESSURE =   1,000 ATM                    VISCOSITY =  1,800E-05 KG/M-SEC
ION MOBILITY =  1,798E-04 M2/VOLT-SEC   MEAN THERMAL SPEED =  4,439E+02 M/SEC     PART. PATH PARAM. =  5,708E-08 M
DUST WEIGHT =  3,250E-06 KG/SEC         LENGTH INCR. = ,25416565 M                INPUT EFF./INCR. = 31,87

ROVRI     ERAVG       EPLT        AFID        CMCD      MMD        WEIGHT     DUST LAYER   J(PART)      J(ION)   INCR. NO.

2,4449   3,622E+05  3,0941E+05  1,0130E+13   25,8    2,90E-06   7,630E-06   2,235E-04   6,60E-07    2,57E-04       1
1,8734   3,622E+05  3,0941E+05  1,3220E+13   25,8    2,16E-06   6,501E-06   1,905E-04   9,11E-05    1,67E-04       2
1,5155   3,622E+05  2,9735E+05  1,6342E+13   25,8    1,69E-06   4,098E-06   1,201E-04   8,20E-07    2,57E-04       3

CALCULATION IS IN SECTION NO. = 2 AND THE SECTION LENGTH IS =  0,7625 M

COLLECTION AREA =  5,813E-01 M2         APPLIED VOLTAGE =  4,580E+04 VOLTS        TOTAL CURRENT =  1,500E-04 AMPS
WIRE TO PLATE =  1,270E-01 M            CORONA WIRE RADIUS =  1,191E-03 M         CORONA WIRE LENGTH =  1,906E+00 M
CURRENT/M =  7,869E-05 AMP/M            CURRENT DENSITY =  2,581E-04 AMP/M2       DEPOSIT E FIELD =  2,581E+03 VOLT/M
1/2 WIRE TO WIRE =  6,350E-02 M         GAS FLOW RATE =  9,460E-02 M3/SEC         GAS VELOCITY =  9,760E-01 M/SEC
TEMPERATURE = 297,667 K                 PRESSURE =   1,000 ATM                    VISCOSITY =  1,800E-05 KG/M-SEC
ION MOBILITY =  1,798E-04 M2/VOLT-SEC   MEAN THERMAL SPEED =  4,439E+02 M/SEC     PART. PATH PARAM. =  5,708E-08 M
DUST WEIGHT =  3,250E-06 KG/SEC         LENGTH INCR. = ,25416565 M                INPUT EFF./INCR. = 31,87

ROVRI     ERAVG       EPLT        AFID        CMCD      MMD        WEIGHT     DUST LAYER   J(PART)      J(ION)   INCR. NO.

1,3051   3,606E+05  2,8592E+05  1,9059E+13   25,8    1,55E-06   2,999E-06   8,786E-05   7,33E-07    2,57E-04       4
1,1825   3,606E+05  2,8002E+05  2,1036E+13   25,8    1,45E-06   2,313E-06   6,775E-05   6,56E-07    2,57E-04       5
1,1095   3,606E+05  2.7674E+05  2,2420E+13   25,8    1,37E-06   1,831E-06   5,363E-05   5,93E-07    2,57E-04       6

CALCULATION IS IN SECTION NO. = 3 AND THE SECTION LENGTH IS =  1,5250 M

COLLECTION AREA =  1,163E+00 M2         APPLIED VOLTAGE =  4,440E+04 VOLTS        TOTAL CURRENT =  3,000E-04 AMPS
WIRE TO PLATE =  1,270E-01 M            CORONA WIRE RADIUS =  1,191E-03 M         CORONA WIRE LENGTH =  3,813E+00 M
CURRENT/M =  7,869E-05 AMP/M            CURRENT DENSITY =  2,581E-04 AMP/M2       DEPOSIT E FIELD =  2,581E+03 VOLT/M
1/2 WIRE TO WIRE =  6,350E-02 M         GAS FLOW RATE =  9,460E-02 M3/SEC         GAS VELOCITY =  9,760E-01 M/SEC
TEMPERATURE = 297,667 K                 PRESSURE =   1,000 ATM                    VISCOSITY =  1,800E-05 KG/M-SEC
ION MOBILITY =  1,798E-04 M2/VOLT-SEC   MEAN THERMAL SPEED =  4,439E+02 M/SEC     PART. PATH PARAM. =  5,708E-08 M
DUST WEIGHT =  3,250E-06 KG/SEC         LENGTH INCR. = ,25416565 M                INPUT EFF./INCR. = 31,87

ROVRI     ERAVG       EPLT        AFID        CMCD      MMD        WEIGHT     DUST LAYER   J(PART)      J(ION)   INCR. NO.

1,0638   3,496E+05  2,6860E+05  2,4119E+13   25,8    1,30E-06   1,438E-06   4,212E-05   5,21E-07    2,58E-04       7
1,0386   3,496E+05  2,6713E+05  2,4706E+13   25,8    1,23E-06   1,171E-06   3,431E-05   4,69E-07    2,58E-04       8
1,0233   3,496E+05  2,6639E+05  2,5074E+13   25,8    1,16E-06   9,642E-07   2,825E-05   4,23E-07    2,58E-04       9
```

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```
1,0141    3,496E+05  2,6639E+05  2,5301E+13    25,8   1,10E-06   6,010E-07   2,347E-05   3,82E-07    2,58E-04      10
1,0086    3,496E+05  2,6639E+05  2,5440E+13    25,8   1,02E-06   6,690E-07   1,960E-05   3,45E-07    2,58E-04      11
1,0052    3,496E+05  2,6639E+05  2,5526E+13    25,8   9,02E-07   5,613E-07   1,644E-05   3,12E-07    2,58E-04      12

EST, EFFICIENCY = 99,00     UNCORRECTED COMPUTED EFFICIENCY = 90,16


INCREMENTAL ANALYSIS OF PRECIPITATOR PERFORMANCE



LAB ESP: SCA=125FT2/1000ACFM;J=24UA/FT2;MMD=2UM;SIGMAP=2,5


CALCULATION IS IN SECTION NO, = 1 AND THE SECTION LENGTH IS =  0,7625 M

COLLECTION AREA =  5,813E-01 M2            APPLIED VOLTAGE =  4,600E+04 VOLTS        TOTAL CURRENT =  1,500E-04 AMPS
WIRE TO PLATE =  1,270E-01 M               CORONA WIRE RADIUS =  1,191E-03 M         CORONA WIRE LENGTH =  1,906E+00 M
CURRENT/M =  7,869E-05 AMP/M               CURRENT DENSITY =  2,581E-04 AMP/M2       DEPOSIT E FIELD =  2,581E+03 VOLT/M
1/2 WIRE TO WIRE =  6,350E-02 M            GAS FLOW RATE =  9,460E-02 M3/SEC         GAS VELOCITY =  9,760E-01 M/SEC
TEMPERATURE = 297,667 K                    PRESSURE =   1,000 ATM                    VISCOSITY =  1,800E-05 KG/M-SEC
ION MOBILITY =  1,798E-04 M2/VOLT-SEC      MEAN THERMAL SPEED =  4,439E+02 M/SEC     PART. PATH PARAM. =  5,708E-08 M
DUST WEIGHT =  3,250E-06 KG/SEC            LENGTH INCR. = ,25416565 M                INPUT EFF./INCR. = 17,58


ROVRI      ERAVG        EPLT         AFID        CMCD      MMD        WEIGHT     DUST LAYER   J(PART)      J(ION)    INCR. NO.

1,7972    3,622E+05  3,0942E+05  1,3780E+13    25,8   2,90E-06   7,630E-06   2,235E-04   6,60E-07    2,57E-04       1
1,5829    3,622E+05  3,0061E+05  1,5646E+13    25,8   2,20E-06   6,480E-06   1,898E-04   1,08E-04    1,50E-04       2
1,4167    3,622E+05  2,9280E+05  1,7482E+13    25,8   1,69E-06   4,084E-06   1,196E-04   8,30E-07    2,57E-04       3

CALCULATION IS IN SECTION NO, = 2 AND THE SECTION LENGTH IS =  0,7625 M

COLLECTION AREA =  5,813E-01 M2            APPLIED VOLTAGE =  4,580E+04 VOLTS        TOTAL CURRENT =  1,500E-04 AMPS
WIRE TO PLATE =  1,270E-01 M               CORONA WIRE RADIUS =  1,191E-03 M         CORONA WIRE LENGTH =  1,906E+00 M
CURRENT/M =  7,869E-05 AMP/M               CURRENT DENSITY =  2,581E-04 AMP/M2       DEPOSIT E FIELD =  2,581E+03 VOLT/M
1/2 WIRE TO WIRE =  6,350E-02 M            GAS FLOW RATE =  9,460E-02 M3/SEC         GAS VELOCITY =  9,760E-01 M/SEC
TEMPERATURE = 297,667 K                    PRESSURE =   1,000 ATM                    VISCOSITY =  1,800E-05 KG/M-SEC
ION MOBILITY =  1,798E-04 M2/VOLT-SEC      MEAN THERMAL SPEED =  4,439E+02 M/SEC     PART. PATH PARAM. =  5,708E-08 M
DUST WEIGHT =  3,250E-06 KG/SEC            LENGTH INCR. = ,25416565 M                INPUT EFF./INCR. = 17,58


ROVRI      ERAVG        EPLT         AFID        CMCD      MMD        WEIGHT     DUST LAYER   J(PART)      J(ION)    INCR. NO.

1,2985    3,606E+05  2,8592E+05  1,9157E+13    25,8   1,55E-06   3,021E-06   8,850E-05   7,46E-07    2,57E-04       4
1,2157    3,606E+05  2,8101E+05  2,0462E+13    25,8   1,45E-06   2,328E-06   6,821E-05   6,67E-07    2,57E-04       5
1,1564    3,606E+05  2,7770E+05  2,1511E+13    25,8   1,37E-06   1,838E-06   5,384E-05   5,98E-07    2,57E-04       6

CALCULATION IS IN SECTION NO, = 3 AND THE SECTION LENGTH IS =  1,5250 M

COLLECTION AREA =  1,163E+00 M2            APPLIED VOLTAGE =  4,440E+04 VOLTS        TOTAL CURRENT =  3,000E-04 AMPS
WIRE TO PLATE =  1,270E-01 M               CORONA WIRE RADIUS =  1,191E-03 M         CORONA WIRE LENGTH =  3,813E+00 M
CURRENT/M =  7,869E-05 AMP/M               CURRENT DENSITY =  2,581E-04 AMP/M2       DEPOSIT E FIELD =  2,581E+03 VOLT/M
1/2 WIRE TO WIRE =  6,350E-02 M            GAS FLOW RATE =  9,460E-02 M3/SEC         GAS VELOCITY =  9,760E-01 M/SEC
TEMPERATURE = 297,667 K                    PRESSURE =   1,000 ATM                    VISCOSITY =  1,800E-05 KG/M-SEC
ION MOBILITY =  1,798E-04 M2/VOLT-SEC      MEAN THERMAL SPEED =  4,439E+02 M/SEC     PART. PATH PARAM. =  5,708E-08 M
DUST WEIGHT =  3,250E-06 KG/SEC            LENGTH INCR. = ,25416565 M                INPUT EFF./INCR. = 17,58


ROVRI      ERAVG        EPLT         AFID        CMCD      MMD        WEIGHT     DUST LAYER   J(PART)      J(ION)    INCR. NO.
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1.1102   3.496E+05  2.7064E+05  2.3112E+13    25.8   1.30E-06   1.447E-06   4.238E-05   5.25E-07     2.56E-04        7
1.0804   3.496E+05  2.6869E+05  2.3748E+13    25.8   1.23E-06   1.174E-06   3.440E-05   4.70E-07     2.56E-04        8
1.0588   3.496E+05  2.6732E+05  2.4233E+13    25.8   1.16E-06   9.636E-07   2.823E-05   4.23E-07     2.56E-04        9
1.0431   3.496E+05  2.6693E+05  2.4598E+13    25.8   1.09E-06   7.990E-07   2.341E-05   3.81E-07     2.56E-04       10
1.0316   3.496E+05  2.6641E+05  2.4872E+13    25.8   1.02E-06   6.659E-07   1.951E-05   3.43E-07     2.56E-04       11
1.0232   3.496E+05  2.6641E+05  2.5077E+13    25.8   9.62E-07   5.588E-07   1.637E-05   3.10E-07     2.56E-04       12
EST EFFICIENCY = 90.18    COMPUTED EFFICIENCY = 90.22     CONVERGES
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CHARGING RATES FOR PARTICLE SIZES FROM SUBROUTINE CHARGN OR CHGSUM

SRI THEORY USED FOR PARTICLE CHARGING

INCREMENT NO.     Q/QSATF FOR INDICATED PARTICLE SIZES

   0.2000E-06   0.4000E-06   0.6000E-06   0.8000E-06   0.1000E-05   0.2000E-05   0.4000E-05   0.6000E-05
 1  1.0360        1.0360       1.0360       1.0360       1.0360       1.0360       1.0360       1.0360
 2  1.5468        1.5324       1.4701       1.4191       1.3809       1.2962       1.2946       1.6600
 3  1.7719        1.7123       1.6141       1.5398       1.4659       1.3633       1.3170       1.6600
 4  1.9177        1.8231       1.7012       1.6121       1.5483       1.4016       1.3319       1.6600
 5  2.0258        1.9037       1.7643       1.6644       1.5934       1.4296       1.3439       1.6600
 6  2.1114        1.9668       1.8136       1.7053       1.6267       1.4513       1.3538       1.6600
 7  2.1791        2.0141       1.8489       1.7335       1.6521       1.4635       1.3579       1.6600
 8  2.2367        2.0544       1.8792       1.7578       1.6725       1.4743       1.3579       1.6600
 9  2.2867        2.0894       1.9057       1.7791       1.6903       1.4840       1.3579       1.6600
10  2.3306        2.1202       1.9290       1.7980       1.7062       1.4927       1.3579       1.6600
11  2.3697        2.1477       1.9499       1.8149       1.7205       1.5006       1.3579       1.6600
12  2.4049        2.1725       1.9687       1.8302       1.7334       1.5078       1.3579       1.6600

   0.8000E-05   0.1000E-04   0.1500E-04   0.2500E-04   0.4000E-04
 1  1.0360        1.0360       1.0360       1.0360       1.0360
 2  2.6859        5.3935      50.2912      *******      *******
 3  2.6859        5.3935      50.2912      *******      *******
 4  2.6859        5.3935      50.2912      *******      *******
 5  2.6859        5.3935      50.2912      *******      *******
 6  2.6859        5.3935      50.2912      *******      *******
 7  2.6859        5.3935      50.2912      *******      *******
 8  2.6859        5.3935      50.2912      *******      *******
 9  2.6859        5.3935      50.2912      *******      *******
10  2.6859        5.3935      50.2912      *******      *******
11  2.6859        5.3935      50.2912      *******      *******
12  2.6859        5.3935      50.2912      *******      *******
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CHARGE ACCUMULATED ON PARTICLE SIZES IN EACH INCREMENT

INCREMENT        CHARGE FOR INDICATED PARTICLE SIZES

        0.2000E-06   0.4000E-06   0.6000E-06   0.8000E-06   0.1000E-05   0.2000E-05   0.4000E-05   0.6000E-05
  1     0.13288E-17  0.42333E-17  0.89135E-17  0.15378E-16  0.23628E-16  0.91693E-16  0.30192E-15  0.81097E-15
  2     0.19839E-17  0.62615E-17  0.12648E-16  0.21063E-16  0.31493E-16  0.11472E-15  0.45225E-15  0.12994E-14
  3     0.22726E-17  0.69964E-17  0.13887E-16  0.22856E-16  0.33888E-16  0.12066E-15  0.46006E-15  0.12994E-14
  4     0.24596E-17  0.74491E-17  0.14636E-16  0.23928E-16  0.35311E-16  0.12406E-15  0.46527E-15  0.12994E-14
  5     0.25982E-17  0.77765E-17  0.15179E-16  0.24705E-16  0.36340E-16  0.12653E-15  0.46948E-15  0.12994E-14
  6     0.27080E-17  0.80365E-17  0.15603E-16  0.25312E-16  0.37144E-16  0.12845E-15  0.47293E-15  0.12994E-14
  7     0.27949E-17  0.82296E-17  0.15907E-16  0.25730E-16  0.37679E-16  0.12952E-15  0.47437E-15  0.12994E-14
  8     0.28688E-17  0.83943E-17  0.16168E-16  0.26091E-16  0.38142E-16  0.13048E-15  0.47437E-15  0.12994E-14
  9     0.29329E-17  0.85373E-17  0.16395E-16  0.26407E-16  0.38550E-16  0.13134E-15  0.47437E-15  0.12994E-14
 10     0.29892E-17  0.86634E-17  0.16597E-16  0.26688E-16  0.38913E-16  0.13211E-15  0.47437E-15  0.12994E-14
 11     0.30394E-17  0.87757E-17  0.16776E-16  0.26939E-16  0.39238E-16  0.13281E-15  0.47437E-15  0.12994E-14
 12     0.30845E-17  0.88768E-17  0.16938E-16  0.27165E-16  0.39533E-16  0.13345E-15  0.47437E-15  0.12994E-14

        0.8000E-05   0.1000E-04   0.1500E-04   0.2500E-04   0.4000E-04
  1     0.14388E-14  0.22455E-14  0.50445E-14  0.13995E-13  0.35804E-13
  2     0.37301E-14  0.11690E-13  0.24487E-12  0.84685E-10  0.31017E-06
  3     0.37301E-14  0.11690E-13  0.24487E-12  0.84685E-10  0.31017E-06
  4     0.37301E-14  0.11690E-13  0.24487E-12  0.84685E-10  0.31017E-06
  5     0.37301E-14  0.11690E-13  0.24487E-12  0.84685E-10  0.31017E-06
  6     0.37301E-14  0.11690E-13  0.24487E-12  0.84685E-10  0.31017E-06
  7     0.37301E-14  0.11690E-13  0.24487E-12  0.84685E-10  0.31017E-06
  8     0.37301E-14  0.11690E-13  0.24487E-12  0.84685E-10  0.31017E-06
  9     0.37301E-14  0.11690E-13  0.24487E-12  0.84685E-10  0.31017E-06
 10     0.37301E-14  0.11690E-13  0.24487E-12  0.84685E-10  0.31017E-06
 11     0.37301E-14  0.11690E-13  0.24487E-12  0.84685E-10  0.31017E-06
 12     0.37301E-14  0.11690E-13  0.24487E-12  0.84685E-10  0.31017E-06
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PARTICLE SIZE RANGE STATISTICS

CORRECTIONS FOR NONIDEALITIES USING SET NO.  1 OF CORRECTION PARAMETERS

   SIZE       CCF  INLET % OUTLET % COR. OUTLET % NO-RAP EFF. NO-RAP W  NO-RAP P  COR. EFF.   COR. W      COR. P
 2.000E-07  1.751  1.867   6.2402        3.9335     89.0109     8.985  10.9891   88.9549     8.964     11.0451
 4.000E-07  1.361  4.594  15.2328        9.6579     89.0997     9.018  10.9003   88.9803     8.974     11.0197
 6.000E-07  1.239  6.081  16.9979       10.8905     90.8101     9.713   9.1899   90.6116     9.626      9.3884
 8.000E-07  1.179  6.560  15.0776        9.6170     92.4668    10.521   7.5332   92.1792    10.369      7.8208
 1.000E-06  1.144  6.530  12.3411        8.2188     93.7871    11.305   6.2129   93.4026    11.061      6.5974
 2.000E-06  1.072 40.039  30.4215       25.8535     97.5022    15.013   2.4978   96.6152    13.777      3.3848
 4.000E-06  1.036 18.907   3.6545       10.3401     99.3646    20.583   0.6354   97.1332    14.452      2.8668
 6.000E-06  1.024  6.522   0.0341        4.9059     99.9828    35.266   0.0172   96.0567    13.155      3.9433
 8.000E-06  1.018  3.916   0.0001        4.2756     99.9999    74.534   0.0001   94.2762    11.639      5.7238
 1.000E-05  1.014  1.699   0.0001        2.5116     99.9999   166.210   0.0001   92.2513    10.407      7.7487
 1.500E-05  1.010  2.522   0.0001        5.7486     99.9999   *******   0.0001   88.0538     8.645     11.9462
 2.500E-05  1.006  0.549   0.0000        2.4734     99.9999   *******   0.0001   76.3822     5.872     23.6178
 4.000E-05  1.004  0.194   0.0000        1.3735     99.9999   *******   0.0001   62.9799     4.043     37.0201

EFFICIENCIES FOR CONVERGENCE CHECK:  STATED OR PREVIOUS CALCULATION =  90.179   FINAL CALCULATION =  90.216

   ADJUSTED NO-RAP EFF. =  96.7125
   MMD OF INLET SIZE DISTRIBUTION =  2.000E+00
   SIGMAP OF INLET SIZE DISTRIBUTION =  2.500E+00
   MMD OF EFFLUENT UNDER NO-RAP CONDITIONS =  8.502E-01
   SIGMAP OF EFFLUENT UNDER NO-RAP CONDITIONS =  1.974E+00
   LOG-NORMAL GOODNESS OF FIT =  1.000
   PRECIPITATION RATE PARAMETER UNDER NO-RAP CONDITIONS = 13.895


   SIGMAG=    0.000  WITH  0.000 SNEAKAGE OVER    4.000  STAGES
   NTEMP = 1
   RMMD =  6.00
   RSIGMA = 2.50
   CORR. EFF. =  94.7581
   CORRECTED MMD OF EFFLUENT =  1.872E+00
   CORRECTED SIGMAP OF EFFLUENT =  3.577E+00
   LOG-NORMAL GOODNESS OF FIT =  0.993
   CORRECTED PRECIPITATION RATE PARAMETER =   12.00
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UNADJUSTED MIGRATION VELOCITIES AND EFFICIENCIES, AND DISCRETE OUTLET MASS LOADINGS

IDEAL UNADJUSTED    IDEAL UNADJUSTED     NO-RAP      RAPPING PUFF    NO-RAP+RAP PUFF    RAPPING PUFF    PARTICLE
   MIG. VEL.           EFFICIENCY       DM/DLOGD       DM/DLOGD         DM/DLOGD        DISTRIBUTION      DIAM.
   (CM/SEC)               (%)           (MG/DSCM)      (MG/DSCM)        (MG/DSCM)           (%)            (M)
   3,696E+00           5,970E+01       1,613E-01      8,224E-04        1,622E-01         5,350E-02      2,000E-07
   4,274E+00           6,502E+01       8,471E-01      9,276E-03        8,563E-01         2,800E-01      4,000E-07
   5,059E+00           7,116E+01       1,435E+00      3,100E-02        1,466E+00         6,176E-01      6,000E-07
   5,878E+00           7,642E+01       1,704E+00      6,508E-02        1,769E+00         9,685E-01      8,000E-07
   6,709E+00           8,078E+01       1,747E+00      1,081E-01        1,855E+00         1,285E+00      1,000E-06
   1,096E+01           9,323E+01       8,914E-01      3,165E-01        1,208E+00         1,617E+01      2,000E-06
   1,960E+01           9,919E+01       1,839E-01      6,457E-01        8,296E-01         2,159E+01      4,000E-06
   3,527E+01           9,998E+01       3,206E-03      7,319E-01        7,351E-01         1,310E+01      6,000E-06
   7,453E+01           1,000E+02       1,224E-05      6,997E-01        6,997E-01         1,147E+01      8,000E-06
   1,862E+02           1,000E+02       8,145E-06      6,303E-01        6,303E-01         6,736E+00      1,000E-05
   2,588E+03           1,000E+02       3,891E-06      4,642E-01        4,642E-01         1,542E+01      1,500E-05
   5,350E+05           1,000E+02       9,873E-07      2,329E-01        2,329E-01         6,634E+00      2,500E-05
   1,222E+09           1,000E+02       3,634E-07      1,343E-01        1,343E-01         3,684E+00      4,000E-05
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*******************************************************************************
*                                                                             *
*                            E.P.A. ESP MODEL                                 *
*                       I.E.R.L.-R.T.P. AND SO.R.I.                           *
*                                                                             *
*                      SUMMARY TABLE OF ESP OPERATING                         *
*                        PARAMETERS AND PERFORMANCE                           *
*                                                                             *
*                                                                             *
*                           DATA SET NUMBER   1                               *
*                                                                             *
*                     NON-IDEAL CONDITION SET NUMBER  1                       *
*                                                                             *
*  ESP PERFORMANCE:     EFFICIENCY =  94,7581 %     SCA =  2,458E+01 M**2/(M**3/SEC)
*                                                        ( 125, FT**2/1000 ACFM)
*                                                                             *
*  ELECTRICAL CONDITIONS:     AVG, APPLIED VOLTAGE =  4,515E+04 V             *
*                             AVG, CURRENT DENSITY =   25,81 NA/CM**2         *
*                             RESISTIVITY =  1,000E+09 OHM-CM                 *
*                                                                             *
*  SIZE DISTRIBUTIONS:     INLET MMD =  2,000E+00 UM     INLET SIGMAP =  2,500E+00
*                          OUTLET MMD =  1,872E+00 UM     OUTLET SIGMAP =  3,577E+00
*                                                                             *
*  NONIDEAL PARAMETERS:     GAS SNEAKAGE FRACTION =  ,00 /SECTION     GAS VELOCITY SIGMAG =  ,00
*                           RAPPING MMD =  6,000E+00 UM     RAPPING SIGMAP =  2.500E+00
*                                                                             *
*******************************************************************************
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*                                   *
*          E.P.A. ESP MODEL         *
*                                   *
*   I.E.R.L.-R.T.P. AND SO.R.I.     *
*                                   *
*           REVISION III            *
*                                   *
*************************************

PRINTOUT OF INPUT DATA FOR DATA SET NUMBER  2


DATA ON CARD NUMBER   1

NENDPT = 14   NDATA =  2   NRAP =  0   MODL =  0   NOPRNT =  0   PATHL =  0.00 FT   NCOMPS =  0   NWAVES =  0  NLAMDA =  0

DATA ON CARD NUMBER   2

LAB ESP: SCA=125FT2/1000ACFM;J=24UA/FT2;MMD=5UM;SIGMAP=2.5

DATA ON CARD NUMBER   3

D50 =   5.0000 UM  SIGMAP =   2.5000
```

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*************************************************************************************

                              E.P.A. ESP MODEL
                         I.E.R.L.-R.T.P. AND SO.R.I.

                        SUMMARY TABLE OF ESP OPERATING
                          PARAMETERS AND PERFORMANCE


                              DATA SET NUMBER    2

                        NON-IDEAL CONDITION SET NUMBER  1

   ESP PERFORMANCE:     EFFICIENCY =  97.5434 %     SCA =  2.456E+01 M**2/(M**3/SEC)
                                                          ( 125. FT**2/1000 ACFM)

   ELECTRICAL CONDITIONS:     AVG. APPLIED VOLTAGE =  4.515E+04 V
                              AVG. CURRENT DENSITY =   25.81 NA/CM**2
                              RESISTIVITY =  1.000E+09 OHM-CM

   SIZE DISTRIBUTIONS:     INLET MMD =  5.000E+00 UM     INLET SIGMAP =  2.500E+00
                          OUTLET MMD =  3.339E+00 UM     OUTLET SIGMAP =  2.616E+00

   NONIDEAL PARAMETERS:     GAS SNEAKAGE FRACTION =  .00 /SECTION     GAS VELOCITY SIGMAG =  .00
                            RAPPING MMD =  6.000E+00 UM     RAPPING SIGMAP =  2.500E+00

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                    *************************************
                    *                                   *
                    *          E.P.A. ESP MODEL         *
                    *                                   *
                    *    I.E.R.L.-R.T.P. AND SO.R.I.    *
                    *                                   *
                    *            REVISION III           *
                    *                                   *
                    *************************************

PRINTOUT OF INPUT DATA FOR DATA SET NUMBER  3


DATA ON CARD NUMBER   1

NENDPT = 14   NDATA =  2   NRAP =  0   MODL =  0   NOPRNT =  0   PATHL =  0.00 FT   NCOMPS =  0   NWAVES =  0  NLAMDA =  0

DATA ON CARD NUMBER   2

LAB ESP: SCA=125FT2/1000ACFM;J=24UA/FT2;MMD=10UM;SIGMAP=2.5

DATA ON CARD NUMBER   3

D50 =  10.0000 UM  SIGMAP =   2.5000
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PARTICLE SIZE RANGE STATISTICS

CORRECTIONS FOR NONIDEALITIES USING SET NO.  1 OF CORRECTION PARAMETERS

  SIZE      CCF  INLET % OUTLET % COR. OUTLET % NO-RAP EFF. NO-RAP W  NO-RAP P  COR. EFF.   COR. W     COR. P
2.000E-07  1.751  0.006   0.1889       0.0957      89.0519     9.000  10.9481   82.1992    7.022    17.8008
4.000E-07  1.361  0.047   1.3953       0.6279      88.9699     8.970  11.0301   84.0661    7.474    15.9319
6.000E-07  1.239  0.131   3.2982       1.4528      90.5943     9.618   9.4057   86.7020    8.209    13.2980
8.000E-07  1.179  0.244   5.0738       2.2476      92.2166    10.388   7.7834   88.9335    8.956    11.0665
1.000E-06  1.144  0.370   6.3991       2.6783      93.5274    11.139   6.4726   90.6556    9.645     9.3444
2.000E-06  1.072  8.035  56.0206      30.5867      97.2945    14.688   2.7055   95.4221   12.548     4.5779
4.000E-06  1.036 14.286  25.4035      22.7763      99.3337    20.390   0.6663   98.0826   16.089     1.9174
6.000E-06  1.024 11.154   0.2031       9.0829      99.9932    39.030   0.0068   99.0206   18.822     0.9794
8.000E-06  1.018 11.626   0.0031       7.8952      99.9999    92.732   0.0001   99.1833   19.561     0.8167
1.000E-05  1.014  7.845   0.0021       4.6379      99.9999   246.383   0.0001   99.2890   20.126     0.7110
1.500E-05  1.010 22.250   0.0059      10.6152      99.9999   *******   0.0001   99.4262   20.998     0.5738
2.500E-05  1.006 13.091   0.0035       4.5673      99.9999   *******   0.0001   99.5804   22.271     0.4196
4.000E-05  1.004 10.913   0.0029       2.5363      99.9999   *******   0.0001   99.7205   23.924     0.2795

EFFICIENCIES FOR CONVERGENCE CHECK:  STATED OR PREVIOUS CALCULATION =  99.115   FINAL CALCULATION =  99.113


   ADJUSTED NO-RAP EFF. =  99.6253
   MMD OF INLET SIZE DISTRIBUTION =  1.000E+01
   SIGMAP OF INLET SIZE DISTRIBUTION =  2.500E+00
   MMD OF EFFLUENT UNDER NO-RAP CONDITIONS =  1.986E+00
   SIGMAP OF EFFLUENT UNDER NO-RAP CONDITIONS =  1.896E+00
   LOG-NORMAL GOODNESS OF FIT =  0.999
   PRECIPITATION RATE PARAMETER UNDER NO-RAP CONDITIONS = 22.732


   SIGMAG=    0.000  WITH  0.000 SNEAKAGE OVER    4.000  STAGES
   NTEMP = 1
   RMMD =  6.00
   RSIGMA = 2.50
   CORR. EFF. =  98.7974
   CORRECTED MMD OF EFFLUENT =  4.515E+00
   CORRECTED SIGMAP OF EFFLUENT =  2.520E+00
   LOG-NORMAL GOODNESS OF FIT =  0.998
   CORRECTED PRECIPITATION RATE PARAMETER =   17.99
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                                      E.P.A. ESP MODEL
                                 I.E.R.L.-R.T.P. AND SO.R.I.

                                SUMMARY TABLE OF ESP OPERATING
                                  PARAMETERS AND PERFORMANCE


                                     DATA SET NUMBER   3

                                NON-IDEAL CONDITION SET NUMBER  1

     ESP PERFORMANCE:     EFFICIENCY =  98.7974 %     SCA =  2.458E+01 M**2/(M**3/SEC)
                                                               ( 125. FT**2/1000 ACFM)

     ELECTRICAL CONDITIONS:     AVG. APPLIED VOLTAGE =  4.515E+04 V

                                AVG. CURRENT DENSITY =   25.81 NA/CM**2

                                RESISTIVITY =  1.000E+09 OHM-CM

     SIZE DISTRIBUTIONS:     INLET MMD =  1.000E+01 UM     INLET SIGMAP =  2.500E+00

                             OUTLET MMD =  4.515E+00 UM    OUTLET SIGMAP =  2.520E+00

     NONIDEAL PARAMETERS:     GAS SNEAKAGE FRACTION =  .00 /SECTION     GAS VELOCITY SIGMAG =  .00

                              RAPPING MMD =  6.000E+00 UM     RAPPING SIGMAP =  2.500E+00

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                    ***************************************
                    *                                     *
                    *          E.P.A. ESP MODEL           *
                    *                                     *
                    *    I.E.R.L.-R.T.P. AND SO.R.I.      *
                    *                                     *
                    *            REVISION III             *
                    *                                     *
                    ***************************************

PRINTOUT OF INPUT DATA FOR DATA SET NUMBER  4


DATA ON CARD NUMBER   1

NENDPT = 14   NDATA =  2   NRAP =  0   MODL =  0   NOPRNT =  0   PATHL =  0.00 FT   NCOMPS =  0   NWAVES =  0  NLAMDA =  0

DATA ON CARD NUMBER   2

LAB ESP: SCA=125FT2/1000ACFM;J=24UA/FT2;MMD=15UM;SIGMAP=2.5

DATA ON CARD NUMBER   3

D50 =  15.0000 UM  SIGMAP =   2.5000
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PARTICLE SIZE RANGE STATISTICS

CORRECTIONS FOR NONIDEALITIES USING SET NO.  1 OF CORRECTION PARAMETERS
                                                                                                    COR. P
  SIZE       CCF  INLET % OUTLET % COR. OUTLET % NO-RAP EFF. NO-RAP W  NO-RAP P  COR. EFF.  COR. W
2.000E-07  1.751  0.001   0.0653      0.0561       89.0791     9.010   10.9209   57.3355    3.466   42.6645
4.000E-07  1.361  0.009   0.6272      0.3568       88.9827     8.975   11.0173   71.4857    5.105   28.5143
6.000E-07  1.239  0.031   1.7776      0.8727       90.5976     9.620    9.4024   79.0000    6.350   21.0000
8.000E-07  1.179  0.066   3.1291      1.4435       92.2145    10.387    7.7855   83.6599    7.371   16.3401
1.000E-06  1.144  0.111   4.3890      1.9672       93.5223    11.136    6.4777   86.7905    8.236   13.2095
2.000E-06  1.072  3.427  56.8907     26.6825       97.2871    14.677    2.7129   94.2110   11.593    5.7890
4.000E-06  1.036  8.307  32.7935     24.0514       99.3548    20.521    0.6452   97.8472   15.618    2.1528
6.000E-06  1.024  7.684   0.2763     10.2836       99.9942    39.714    0.0058   99.0301   18.862    0.9699
8.000E-06  1.018  9.436   0.0058      8.9461       99.9999    95.509    0.0001   99.2949   20.159    0.7051
1.000E-05  1.014  7.102   0.0044      5.2564       99.9999   255.557    0.0001   99.4497   21.168    0.5503
1.500E-05  1.010 24.025   0.0147     12.0309       99.9999   *******    0.0001   99.6276   22.757    0.3724
2.500E-05  1.006 18.086   0.0111      5.1764       99.9999   *******    0.0001   99.7872   25.033    0.2128
4.000E-05  1.004 21.515   0.0132      2.8746       99.9999   *******    0.0001   99.9007   28.133    0.0993

EFFICIENCIES FOR CONVERGENCE CHECK:  STATED OR PREVIOUS CALCULATION =  99.635   FINAL CALCULATION =  99.635


    ADJUSTED NO-RAP EFF. =  99.8366
    MMD OF INLET SIZE DISTRIBUTION =  1.500E+01
    SIGMAP OF INLET SIZE DISTRIBUTION =  2.500E+00
    MMD OF EFFLUENT UNDER NO-RAP CONDITIONS =  2.330E+00
    SIGMAP OF EFFLUENT UNDER NO-RAP CONDITIONS =  1.864E+00
    LOG-NORMAL GOODNESS OF FIT =  0.998
    PRECIPITATION RATE PARAMETER UNDER NO-RAP CONDITIONS = 26.108


    SIGMAG=    0.000  WITH  0.000 SNEAKAGE OVER    4.000  STAGES
    NTEMP = 1
    RMMD =  6.00
    RSIGMA = 2.50
    CORR. EFF. =  99.2564
    CORRECTED MMD OF EFFLUENT =  5.074E+00
    CORRECTED SIGMAP OF EFFLUENT =  2.448E+00
    LOG-NORMAL GOODNESS OF FIT =  0.999
    CORRECTED PRECIPITATION RATE PARAMETER =   19.94
```

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********************************************************************************************************
*                                                                                                      *
*                                         E.P.A. ESP MODEL                                             *
*                                   I.E.R.L.-R.T.P. AND SO.R.I.                                        *
*                                                                                                      *
*                                  SUMMARY TABLE OF ESP OPERATING                                      *
*                                    PARAMETERS AND PERFORMANCE                                        *
*                                                                                                      *
*                                                                                                      *
*                                        DATA SET NUMBER   4                                           *
*                                                                                                      *
*                                 NON-IDEAL CONDITION SET NUMBER  1                                    *
*                                                                                                      *
*         ESP PERFORMANCE:     EFFICIENCY =  99.2564 %     SCA =  2.458E+01 M**2/(M**3/SEC)            *
*                                                               ( 125. FT**2/1000 ACFM)                *
*                                                                                                      *
*         ELECTRICAL CONDITIONS:     AVG. APPLIED VOLTAGE =  4.515E+04 V                               *
*                                    AVG. CURRENT DENSITY =   25.81 NA/CM**2                           *
*                                    RESISTIVITY =  1.000E+09 OHM-CM                                   *
*                                                                                                      *
*         SIZE DISTRIBUTIONS:     INLET MMD =  1.500E+01 UM     INLET SIGMAP =  2.500E+00              *
*                                 OUTLET MMD =  5.074E+00 UM     OUTLET SIGMAP =  2.448E+00            *
*                                                                                                      *
*         NONIDEAL PARAMETERS:     GAS SNEAKAGE FRACTION =  .00 /SECTION     GAS VELOCITY SIGMAG =  .00*
*                                  RAPPING MMD =  6.000E+00 UM     RAPPING SIGMAP =  2.500E+00         *
*                                                                                                      *
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*                                   *
*          E.P.A. ESP MODEL         *
*                                   *
*    I.E.R.L.-R.T.P. AND SO.R.I.    *
*                                   *
*           REVISION III            *
*                                   *
*************************************

PRINTOUT OF INPUT DATA FOR DATA SET NUMBER  5


DATA ON CARD NUMBER   1

NENDPT = 14   NDATA =  2   NRAP =  0   NUDL =  0   NOPRNT =  0   PATHL =  0.00 FT   NCOMPS =  0   NRAVES =  0  NLAMDA =  0

DATA ON CARD NUMBER   2

LAB ESP: SCA=125FT2/1000ACFM;J=240A/FT2;MMD=25UM;SIGMAP=2.5

DATA ON CARD NUMBER   3

D50 =  25.0000 UM  SIGMAP =   2.5000
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PARTICLE SIZE RANGE STATISTICS

CORRECTIONS FOR NONIDEALITIES USING SET NO.  1 OF CORRECTION PARAMETERS

  SIZE      CCF  INLET % OUTLET % COR. OUTLET % NO-RAP EFF. NO-RAP W  NO-RAP P  COR. EFF.  COR. W     COR. P
2.000E-07  1.751  0.000   0.0159       0.0020      89.0857     9.013  10.9143   89.0857    9.013     10.9143
4.000E-07  1.361  0.001   0.2117       0.0262      88.9779     8.973  11.0221   88.9779    8.973     11.0221
6.000E-07  1.239  0.004   0.7516       0.6362      90.5865     9.615   9.4135   35.5084    1.789     64.4316
8.000E-07  1.179  0.010   1.5657       1.0454      92.2065    10.380   7.7495   57.8802    3.519     42.1136
1.000E-06  1.144  0.018   2.5091       1.4403      93.5071    11.126   6.4929   69.8598    4.880     30.1402
2.000E-06  1.072  0.904  51.9322      22.4024      97.2750    14.659   2.7250   90.4936    9.575      9.5064
4.000E-06  1.036  3.202  42.4110      24.2294      99.3719    20.630   0.6281   97.0983   14.403      2.9017
6.000E-06  1.024  3.863   0.4084      11.5726      99.9950    40.285   0.0050   98.8513   18.174      1.1487
8.000E-06  1.018  5.501   0.0116      10.0858      99.9999    98.072   0.0001   99.2970   20.171      0.7030
1.000E-05  1.014  4.745   0.0100       5.9247      99.9999   263.932   0.0001   99.5212   21.734      0.4788
1.500E-05  1.010 20.198   0.0427      13.5605      99.9999   *******   0.0001   99.7425   24.259      0.2575
2.500E-05  1.006 20.697   0.0437       5.8345      99.9999   *******   0.0001   99.8919   27.789      0.1081
4.000E-05  1.004 40.856   0.0863       3.2402      99.9999   *******   0.0001   99.9696   32.950      0.0304

EFFICIENCIES FOR CONVERGENCE CHECK:  STATED OR PREVIOUS CALCULATION =  99.901   FINAL CALCULATION =  99.902


   ADJUSTED NO-RAP EFF. =  99.9526
   MMD OF INLET SIZE DISTRIBUTION =  2.500E+01
   SIGMAP OF INLET SIZE DISTRIBUTION =  2.500E+00
   MMD OF EFFLUENT UNDER NO-RAP CONDITIONS =  2.783E+00
   SIGMAP OF EFFLUENT UNDER NO-RAP CONDITIONS =  1.826E+00
   LOG-NORMAL GOODNESS OF FIT =  0.998
   PRECIPITATION RATE PARAMETER UNDER NO-RAP CONDITIONS = 31.142


   SIGMAG=    0.000  WITH  0.000 SNEAKAGE OVER    4.000  STAGES
   NTEMP = 1
   RMMD =  6.00
   RSIGMA = 2.50
   CORR. EFF. =  99.6165
   CORRECTED MMD OF EFFLUENT =  5.857E+00
   CORRECTED SIGMAP OF EFFLUENT =  2.217E+00
   LOG-NORMAL GOODNESS OF FIT =  0.993
   CORRECTED PRECIPITATION RATE PARAMETER =   22.64
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                              E.P.A. ESP MODEL
                          I.E.R.L.-R.T.P. AND SO.R.I.

                         SUMMARY TABLE OF ESP OPERATING
                           PARAMETERS AND PERFORMANCE


                              DATA SET NUMBER   5

                         NON-IDEAL CONDITION SET NUMBER  1

    ESP PERFORMANCE:     EFFICIENCY =  99.6165 %     SCA =  2.458E+01 M**2/(M**3/SEC)
                                                          ( 125. FT**2/1000 ACFM)

    ELECTRICAL CONDITIONS:     AVG. APPLIED VOLTAGE =  4.515E+04 V
                               AVG. CURRENT DENSITY =   25.81 NA/CM**2
                               RESISTIVITY =  1.000E+09 OHM-CM

    SIZE DISTRIBUTIONS:     INLET MMD =  2.500E+01 UM     INLET SIGMAP =  2.500E+00
                            OUTLET MMD =  5.857E+00 UM     OUTLET SIGMAP =  2.217E+00

    NONIDEAL PARAMETERS:     GAS SNEAKAGE FRACTION =  .00 /SECTION     GAS VELOCITY SIGMAG =  .00
                             RAPPING MMD =  6.000E+00 UM     RAPPING SIGMAP =  2.500E+00

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                              *                                      *
                              *          E.P.A. ESP MODEL            *
                              *                                      *
                              *   I.E.R.L.-R.T.P. AND SO.R.I.        *
                              *                                      *
                              *           REVISION III               *
                              *                                      *
                              ****************************************

PRINTOUT OF INPUT DATA FOR DATA SET NUMBER  6


DATA ON CARD NUMBER   1

NENDPT = 14   NDATA =  2   NRAP =  0   NODL =  0   NOPRNT =  0   PATHL =  0.00 FT   NCOAPS =  0   NWAVES =  0  NLAMDA =  0

DATA ON CARD NUMBER   2

LAB ESP: SCA=125FT2/1000ACFM;J=24[illegible]/FT2;MMD=10UM;SIGMAP=1.5

DATA ON CARD NUMBER   3

D50 =  10.0000 UM  SIGMAP =   1.5000
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PARTICLE SIZE RANGE STATISTICS

CORRECTIONS FOR NONIDEALITIES USING SET NO.  1 OF CORRECTION PARAMETERS

   SIZE      CCF  INLET % OUTLET % COR. OUTLET % NO-RAP EFF. NO-RAP W  NO-RAP P  COR. EFF.   COR. W     COR. P
2.000E-07  1.751  0.000   0.0000        0.0000     89.1002     9.018   10.6998   89.1002     9.018    10.6998
4.000E-07  1.361  0.000   0.0000        0.0000     89.0013     8.981   10.9987   89.0013     8.981    10.9987
6.000E-07  1.239  0.000   0.0000        0.0000     90.6138     9.627    9.3862   90.6138     9.627     9.3862
8.000E-07  1.179  0.000   0.0000        0.0000     92.2287    10.395    7.7713   92.2287    10.395     7.7713
1.000E-06  1.144  0.000   0.0005        0.0001     93.5347    11.143    6.4653   93.5347    11.143     6.4653
2.000E-06  1.072  0.113   8.9330       17.7113     97.2936    14.687    2.7064   50.4315     2.856    49.5685
4.000E-06  1.036  4.726  86.6159       29.4849     99.3561    20.529    0.6439   98.0209    15.960     1.9791
6.000E-06  1.024 13.167   2.2115       12.3120     99.9942    39.714    0.0058   99.7034    23.682     0.2966
8.000E-06  1.018 22.798   0.0665       10.5676     99.9999    95.602    0.0001   99.8530    26.538     0.1470
1.000E-05  1.014 17.612   0.0514        6.2077     99.9999   255.792    0.0001   99.8882    27.652     0.1118
1.500E-05  1.010 36.059   0.1051       14.2083     99.9999   *******    0.0001   99.8750    27.199     0.1250
2.500E-05  1.006  5.255   0.0153        6.1133     99.9999   *******    0.0001   99.6310    22.794     0.3690
4.000E-05  1.004  0.270   0.0008        3.3949     99.9999   *******    0.0001   96.0090    13.106     3.9910

EFFICIENCIES FOR CONVERGENCE CHECK:  STATED OR PREVIOUS CALCULATION =  99.952   FINAL CALCULATION =  99.952

   ADJUSTED NO-RAP EFF. =  99.9657
   MMD OF INLET SIZE DISTRIBUTION =  1.000E+01
   SIGMAP OF INLET SIZE DISTRIBUTION =  1.500E+00
   MMD OF EFFLUENT UNDER NO-RAP CONDITIONS =  3.598E+00
   SIGMAP OF EFFLUENT UNDER NO-RAP CONDITIONS =  1.342E+00
   LOG-NORMAL GOODNESS OF FIT =  0.989
   PRECIPITATION RATE PARAMETER UNDER NO-RAP CONDITIONS = 32.455


   SIGMAG=    0.000  WITH  0.000 SNEAKAGE OVER    4.000  STAGES
   NTEMP = 1
   RMMD =  6.00
   RSIGMA = 2.50
   CORR. EFF. =  99.6828
   CORRECTED MMD OF EFFLUENT =  8.209E+00
   CORRECTED SIGMAP OF EFFLUENT =  1.535E+00
   LOG-NORMAL GOODNESS OF FIT =  0.978
   CORRECTED PRECIPITATION RATE PARAMETER =   23.41
```

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************************************************************************************************************************
*                                                                                                                      *
*                                           E.P.A. ESP MODEL                                                           *
*                                      I.E.R.L.-R.T.P. AND SO.R.I.                                                     *
*                                                                                                                      *
*                                     SUMMARY TABLE OF ESP OPERATING                                                   *
*                                       PARAMETERS AND PERFORMANCE                                                     *
*                                                                                                                      *
*                                                                                                                      *
*                                          DATA SET NUMBER   6                                                         *
*                                                                                                                      *
*                                     NON-IDEAL CONDITION SET NUMBER  1                                                *
*                                                                                                                      *
*            ESP PERFORMANCE:     EFFICIENCY =  99.6828 %     SCA =  2,456E+01 M**2/(M**3/SEC)                         *
*                                                                                                                      *
*                                                                 ( 125. FT**2/1000 ACFM)                              *
*                                                                                                                      *
*            ELECTRICAL CONDITIONS:     AVG, APPLIED VOLTAGE =  4.515E+04 V                                            *
*                                                                                                                      *
*                                       AVG, CURRENT DENSITY =   25.81 NA/CM**2                                        *
*                                                                                                                      *
*                                       RESISTIVITY =  1,000E+09 OHM-CM                                                *
*                                                                                                                      *
*            SIZE DISTRIBUTIONS:     INLET MMD =  1.000E+01 UM     INLET SIGMAP =  1,500E+00                           *
*                                                                                                                      *
*                                    OUTLET MMD =  8.209E+00 UM     OUTLET SIGMAP =  1,535E+00                         *
*                                                                                                                      *
*            NONIDEAL PARAMETERS:     GAS SNEAKAGE FRACTION =  .00 /SECTION     GAS VELOCITY SIGMAG =  .00             *
*                                                                                                                      *
*                                     RAPPING MMD =  6.000E+00 UM     RAPPING SIGMAP =  2,500E+00                      *
*                                                                                                                      *
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                  ************************************
                  *                                  *
                  *          E.P.A. ESP MODEL        *
                  *                                  *
                  *    I.E.R.L.-R.T.P. AND SO.R.I.   *
                  *                                  *
                  *           REVISION III           *
                  *                                  *
                  ************************************

PRINTOUT OF INPUT DATA FOR DATA SET NUMBER  7


DATA ON CARD NUMBER   1

NENDPT = 14   NDATA =  2   NRAP =  0   MODL =  0   NUPRNT =  0   PATHL =  0.00 FT   NCOMPS =  0   NWAVES =  0  NLAMDA =  0

DATA ON CARD NUMBER   2

LAB ESP: SCA=125FT2/1000ACFM;J=20A/FT2;MMD=10UM;SIGMAP=5.0

DATA ON CARD NUMBER   3

D50 =  10.0000 UM  SIGMAP =   5.0000
```

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PARTICLE SIZE RANGE STATISTICS

CORRECTIONS FOR NONIDEALITIES USING SET NO.  1 OF CORRECTION PARAMETERS

  SIZE       CCF  INLET % OUTLET % COR. OUTLET % NO-RAP EFF. NO-RAP W  NO-RAP P  COR. EFF.   COR. W     COR. P
2,000E-07  1,751  1,259  11,7569        5,5538      89,0261      8,991  10,9739   88,9698    8,970    11,0302
4,000E-07  1,361  1,671  15,6121        7.4860      89,0162      8,987  10,9838   88,7936    8,905    11,2064
6,000E-07  1,239  1,793  14,2184        7,0097      90,6781      9,654   9.3219   90,2214    9.460     9,7786
8,000E-07  1,179  1,811  11,8382        6,0770      92,3161     10.441   7,6839   91,6072   10,082     8,3928
1,000E-06  1,144  1,785   9,6681        5,2247      93,6320     11,205   6,3680   92,6776   10,637     7,3224
2,000E-06  1,072 13,608  30,2974       23,8699      97,3830     14,823   2,6170   95,6129   12,721     4,3871
4,000E-06  1,036 11,718   6,5373       14,5138      99,3442     20,454   0,6558   96,9022   14,137     3,0978
6,000E-06  1,024  7,114   0,0666        6,9752      99,9890     37,086   0,0110   97,5479   15,088     2,4521
8,000E-06  1,018  6,795   0,0006        6,0782      99,9999     83,675   0,0001   97,7628   15,461     2,2372
1,000E-05  1,014  4,481   0,0004        3,5705      99,9999    216,980   0,0001   98,0071   15,932     1,9929
1,500E-05  1,010 13,512   0,0012        8,1723      99,9999    *******   0,0001   98,4873   17,054     1,5127
2,500E-05  1,006 10,237   0,0009        3,5162      99,9999    *******   0,0001   99,1410   19,356     0,6590
4,000E-05  1,004 24,217   0,0021        1,9526      99,9999    *******   0,0001   99,7983   25,252     0,2017
EFFICIENCIES FOR CONVERGENCE CHECK:  STATED OR PREVIOUS CALCULATION =  98,556   FINAL CALCULATION =  98,554

   ADJUSTED NO-RAP EFF. =  98,8246
   MMD OF INLET SIZE DISTRIBUTION =  1,000E+01
   SIGMAP OF INLET SIZE DISTRIBUTION =  5,000E+00
   MMD OF EFFLUENT UNDER NO-RAP CONDITIONS =  8,275E-01
   SIGMAP OF EFFLUENT UNDER NO-RAP CONDITIONS =  2,319E+00
   LOG-NORMAL GOODNESS OF FIT =  1,000
   PRECIPITATION RATE PARAMETER UNDER NO-RAP CONDITIONS = 18,060


   SIGMAG=    0,000  WITH  0,000 SNEAKAGE OVER    4,000  STAGES
   NTEMP = 1
   RMMD =  6,00
   RSIGMA = 2,50
   CORR. EFF. =  97,4990
   CORRECTED MMD OF EFFLUENT =  2,324E+00
   CORRECTED SIGMAP OF EFFLUENT =  3,824E+00
   LOG-NORMAL GOODNESS OF FIT =  0,998
   CORRECTED PRECIPITATION RATE PARAMETER =   15,01
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*                                                                                         *
*                                  E.P.A. ESP MODEL                                       *
*                             I.E.R.L.-R.T.P. AND SO.R.I.                                 *
*                                                                                         *
*                            SUMMARY TABLE OF ESP OPERATING                               *
*                              PARAMETERS AND PERFORMANCE                                 *
*                                                                                         *
*                                                                                         *
*                                  DATA SET NUMBER   7                                    *
*                                                                                         *
*                            NON-IDEAL CONDITION SET NUMBER  1                            *
*                                                                                         *
*       ESP PERFORMANCE:     EFFICIENCY =  97.4990 %     SCA =  2.458E+01 M**2/(M**3/SEC) *
*                                                                                         *
*                                                          ( 125. FT**2/1000 ACFM)        *
*                                                                                         *
*       ELECTRICAL CONDITIONS:     AVG. APPLIED VOLTAGE =  4.515E+04 V                    *
*                                                                                         *
*                                  AVG. CURRENT DENSITY =   25.81 NA/CM**2                *
*                                                                                         *
*                                  RESISTIVITY =  1.000E+09 OHM-CM                        *
*                                                                                         *
*       SIZE DISTRIBUTIONS:     INLET MMD =  1.000E+01 UM     INLET SIGMAP =  5.000E+00   *
*                                                                                         *
*                               OUTLET MMD =  2.324E+00 UM     OUTLET SIGMAP =  3.824E+00 *
*                                                                                         *
*       NONIDEAL PARAMETERS:     GAS SNEAKAGE FRACTION =  .00 /SECTION     GAS VELOCITY SIGMAG =  .00 *
*                                                                                         *
*                                RAPPING MMD =  6.000E+00 UM     RAPPING SIGMAP =  2.500E+00 *
*                                                                                         *
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*                                   *
*          E.P.A. ESP MODEL         *
*                                   *
*    I.E.R.L.-R.T.P. AND SO.R.I.    *
*                                   *
*           REVISION III            *
*                                   *
*************************************

PRINTOUT OF INPUT DATA FOR DATA SET NUMBER  8


DATA ON CARD NUMBER   1

NENDPT = 14   NDATA =  2   NRAP =  0   MODL =  0   NOPRNT =  0   PATHL =  0.00 FT   NCOMPS =  0   NWAVES =  0  NLAMDA =  0

DATA ON CARD NUMBER   2

LAB ESP: SCA=125FT2/1000ACFM;J=20A/FT2;MMD=10UM;SIGMAP=10.0

DATA ON CARD NUMBER   3

D50 =  10.0000 UM  SIGMAP =  10.0000
```

```
PARTICLE SIZE RANGE STATISTICS


CORRECTIONS FOR NONIDEALITIES USING SET NO.  1 OF CORRECTION PARAMETERS

   SIZE      CCF  INLET % OUTLET % COR. OUTLET % NO-RAP EFF. NO-RAP W  NO-RAP P  COR. EFF.   COR. W     COR. P
 2,000E-07  1,751  4,216  25,8428       13,8212      89,0373     8,995  10,9627   89,0175    8,987     10,9825
 4,000E-07  1,361  3,354  20,4240       11,0343      89,1084     9,021  10,8916   88,9778    8,973     11,0222
 6,000E-07  1,239  2,812  14,4513        8,0028      90,8083     9,712   9,1917   90,4653    9,563      9,5347
 8,000E-07  1,179  2,436  10,2696        5,9339      92,4597    10,517   7,5403   91,8387   10,196      8,1613
 1,000E-06  1,144  2,156   7,5021        4,6039      93,7772    11,299   6,2228   92,8466   10,732      7,1534
 2,000E-06  1,072 12,967  18,1880       18,1799      97,4915    14,995   2,5085   95,3032   12,444      4,6968
 4,000E-06  1,036  9,176   3,2719       11,8091      99,3623    20,568   0,6377   95,6887   12,792      4,3113
 6,000E-06  1,024  5,227   0,0470        6,1320      99,9839    35,543   0,0161   96,0697   13,169      3,9303
 8,000E-06  1,018  4,885   0,0003        5,3456      99,9999    76,136   0,0001   96,3343   13,452      3,6657
 1,000E-05  1,014  3,204   0,0002        3,1402      99,9999   191,267   0,0001   96,7161   13,900      3,2839
 1,500E-05  1,010  9,809   0,0005        7,1873      99,9999   *******   0,0001   97,5454   15,084      2,4546
 2,500E-05  1,006  7,917   0,0004        3,0924      99,9999   *******   0,0001   98,6914   17,643      1,3086
 4,000E-05  1,004 31,841   0,0018        1,7173      99,9999   *******   0,0001   99,8193   25,699      0,1807

EFFICIENCIES FOR CONVERGENCE CHECK:  STATED OR PREVIOUS CALCULATION =  94,376   FINAL CALCULATION =  94,374


   ADJUSTED NO-RAP EFF. =  98,2115
   MMD OF INLET SIZE DISTRIBUTION =  1,000E+01
   SIGMAP OF INLET SIZE DISTRIBUTION =  1,000E+01
   MMD OF EFFLUENT UNDER NO-RAP CONDITIONS =  5,428E-01
   SIGMAP OF EFFLUENT UNDER NO-RAP CONDITIONS =  2,488E+00
   LOG-NORMAL GOODNESS OF FIT =  1,000
   PRECIPITATION RATE PARAMETER UNDER NO-RAP CONDITIONS = 16,372


   SIGMAG=    0,000  WITH  0,000 SNEAKAGE OVER    4,000  STAGES
   NTEMP = 1
   RMMD =  6,00
   RSIGMA = 2,50
   CORR. EFF. =  96,6499
   CORRECTED MMD OF EFFLUENT =  1,569E+00
   CORRECTED SIGMAP OF EFFLUENT =  4,785E+00
   LOG-NORMAL GOODNESS OF FIT =  0,994
   CORRECTED PRECIPITATION RATE PARAMETER =   13,82
```

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*****************************************************************************************

                              E.P.A. ESP MODEL
                       I.E.R,L.-R.T.P. AND SO.R.I.

                     SUMMARY TABLE OF ESP OPERATING
                       PARAMETERS AND PERFORMANCE


                            DATA SET NUMBER    8

                     NON-IDEAL CONDITION SET NUMBER  1

ESP PERFORMANCE:     EFFICIENCY =  96,6499 %     SCA =  2,458E+01 M**2/(M**3/SEC)
                                                      ( 125. FT**2/1000 ACFM)

ELECTRICAL CONDITIONS:     AVG, APPLIED VOLTAGE =  4,515E+04 V
                           AVG, CURRENT DENSITY =   25,81 NA/CM**2
                           RESISTIVITY =  1,000E+09 OHM-CM

SIZE DISTRIBUTIONS:     INLET MMD =  1,000E+01 UM     INLET SIGMAP =  1,000E+01
                        OUTLET MMD =  1,564E+00 UM     OUTLET SIGMAP =  4,785E+00

NONIDEAL PARAMETERS:     GAS SNEAKAGE FRACTION =  ,00 /SECTION     GAS VELOCITY SIGMAG =  ,00
                         RAPPING MMD =  6,000E+00 UM     RAPPING SIGMAP =  2,500E+00

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                    *************************************
                    *                                   *
                    *         E.P.A. ESP MODEL          *
                    *                                   *
                    *    I.E.R.L.-R.T.P. AND SO.R.I.    *
                    *                                   *
                    *            REVISION III           *
                    *                                   *
                    *************************************

PRINTOUT OF INPUT DATA FOR DATA SET NUMBER  9


DATA ON CARD NUMBER   1

NENDPT = 14   NDATA =  2   NRAP =  0   MODL =  0   NOPRNT =  0   PATHL =  0.00 FT   NCOMPS =  0   NWAVES =  0  NLAMDA =  0

DATA ON CARD NUMBER   2

LAB ESP; SCA=125FT2/1000ACFM;J=24UA/FT2;MMD=10UM;SIGMAP=15.0

DATA ON CARD NUMBER   3

D50 =  10.0000 UM  SIGMAP =  15.0000
```

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PARTICLE SIZE RANGE STATISTICS

CORRECTIONS FOR NONIDEALITIES USING SET NO.  1 OF CORRECTION PARAMETERS

  SIZE      CCF  INLET % OUTLET % CUR. OUTLET % NO-RAP EFF. NO-RAP W  NO-RAP P  CUR. EFF.   CUR. W     CUR. P
2.000E-07 1.751  5.596  30.8793      17.0092      89.0353     8.994  10.5647   89.0198    8.988    10.9802
4.000E-07 1.361  3.855  21.0800      11.7213      89.1349     9.031  10.8651   89.0166    8.987    10.9834
6.000E-07 1.239  3.025  13.9322       7.9413      90.8481     9.729   9.1519   90.5163    9.564     9.4837
8.000E-07 1.179  2.515   9.4887       5.6550      92.5042    10.542   7.4958   91.8783   10.215     8.1217
1.000E-06 1.144  2.164   6.7276       4.2786      93.8225    11.329   6.1775   92.8574   10.738     7.1426
2.000E-06 1.072 12.239  15.2479      16.5629      97.5244    15.049   2.4756   95.1111   12.280     4.8869
4.000E-06 1.036  8.212   2.5998      11.1429      99.3709    20.823   0.6291   95.0980   12.270     4.9020
6.000E-06 1.024  4.598   0.0416       5.9177      99.9820    35.084   0.0180   95.3509   12.485     4.6491
8.000E-06 1.018  4.273   0.0002       5.1599      99.9999    73.537   0.0001   95.6381   12.745     4.3619
1.000E-05 1.014  2.798   0.0001       3.031         9999   182.847   0.0001   96.0865   13.186     3.9135
1.500E-05 1.010  8.603   0.0004       6.9             9    *******   0.0001   97.0867   14.367     2.9133
2.500E-05 1.006  7.061   0.0004       2.                   *******   0.0001   98.4728   17.015     1.5272
4.000E-05 1.004 35.060   0.0018       1.                   *******   0.0001   99.8292   25.928     0.1708

EFFICIENCIES FOR CONVERGENCE CHECK:  ST                   CULATION =  93.629   FINAL CALCULATION =  93.634

   ADJUSTED NO-RAP EFF. =  98.0129
   MMD OF INLET SIZE DISTRIBUTION =  1.00
   SIGMAP OF INLET SIZE DISTRIBUTION =  1.
   MMD OF EFFLUENT UNDER NO-RAP CONDITIONS =
   SIGMAP OF EFFLUENT UNDER NO-RAP CONDITIONS =  2.  3E+00
   LOG-NORMAL GOODNESS OF FIT =  1.000
   PRECIPITATION RATE PARAMETER UNDER NO-RAP CONDITIONS = 15.944


   SIGMAG=    0.000  WITH  0.000 SNEAKAGE OVER    4.000  STAGES
   NTEMP = 1
   RMMD =  6.00
   RSIGMA = 2.50
   CORR. EFF. =  96.3874
   CORRECTED MMD OF EFFLUENT =  1.384E+00
   CORRECTED SIGMAP OF EFFLUENT =  5.139E+00
   LOG-NORMAL GOODNESS OF FIT =  0.993
   CORRECTED PRECIPITATION RATE PARAMETER =   13.51
```

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*****************************************************************************************************
*                                                                                                   *
*                                      E.P.A. ESP MODEL                                             *
*                                 I.E.R.L.-R.T.P. AND SO.R.I.                                       *
*                                                                                                   *
*                                SUMMARY TABLE OF ESP OPERATING                                     *
*                                  PARAMETERS AND PERFORMANCE                                       *
*                                                                                                   *
*                                                                                                   *
*                                      DATA SET NUMBER    9                                         *
*                                                                                                   *
*                                NON-IDEAL CONDITION SET NUMBER  1                                  *
*                                                                                                   *
*    ESP PERFORMANCE:     EFFICIENCY =  96.3874 %     SCA =  2.458E+01 M**2/(M**3/SEC)              *
*                                                           ( 125. FT**2/1000 ACFM)                 *
*                                                                                                   *
*    ELECTRICAL CONDITIONS:     AVG. APPLIED VOLTAGE =  4.515E+04 V                                 *
*                               AVG. CURRENT DENSITY =   25.61 NA/CM**2                             *
*                               RESISTIVITY =  1.000E+09 OHM-CM                                     *
*                                                                                                   *
*    SIZE DISTRIBUTIONS:     INLET MMD =  1.000E+01 UM     INLET SIGMAP =  1.500E+01                *
*                            OUTLET MMD =  1.384E+00 UM     OUTLET SIGMAP =  5.139E+00              *
*                                                                                                   *
*    NONIDEAL PARAMETERS:     GAS SNEAKAGE FRACTION =  .00 /SECTION     GAS VELOCITY SIGMAG =  .00  *
*                             RAPPING MMD =  6.000E+00 UM     RAPPING SIGMAP =  2.500E+00           *
*                                                                                                   *
*****************************************************************************************************
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APPENDIX H

OUTPUT DATA FROM EXAMPLE 8

```
                    ************************************
                    *                                  *
                    *          E.P.A. ESP MODEL        *
                    *                                  *
                    *    I.E.R.L.-R.T.P. AND SO.R.I.   *
                    *                                  *
                    *           REVISION III           *
                    *                                  *
                    ************************************

 PRINTOUT OF INPUT DATA FOR DATA SET NUMBER  1


>>>>> CHECK VALUE OF DL

>>>>> CHECK VALUE OF AS( 1)

>>>>> CHECK VALUE OF TEMPS( 1)

>>>>> CHECK VALUE OF AS( 2)

>>>>> CHECK VALUE OF TEMPS( 2)

>>>>> CHECK VALUE OF TEMPS( 3)

 DATA ON CARD NUMBER   1

 NENDPT = 10   NDATA =  1   NRAP =  0   NODL =  0   NOPRNT =  0   PATHL =  0.00 FT   NCOMPS =  0   NWAVES =  0  NLAMDA =  0

 DATA ON CARD NUMBER   2

 LAB ESP: SCA=50FT2/1000ACFM;J=24UA/FT2

 DATA ON CARD NUMBER   3

 NEST =  1  NDIST =  1  NVI =  1  NX = 10  NY = 10  NITER =  3  NCALC =  0  NRAPD =  1  NEFF =  1  NTEMP =  1  NONID =  1

 DATA ON CARD NUMBER   4

 NN =  5

 DATA ON CARD NUMBER   5

 DL =  0.01500 GRN/ACF  PL =  10.0000 FT  ETAU = 99.00000 %  RHO =  1000.00 KG/M**3  EPS =  5.100E+00
 VRATIO =   1.0300  BS =  .000165 M**2/V-SEC  FPATH =   1.0000  EBD = 1500000. V/M  RHOCGS =  1.00E+09 OHM-CM
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DATA ON CARD NUMBER   6

ABNUCK( 1) =  ,00  AZIGGY( 1) =  ,00  AZAUMS( 1) =  4,0


DATA ON CARD NUMBER   7

ENDPT( 1) =    0,200 UM   ENDPT( 2) =    0,300 UM   ENDPT( 3) =    0,400 UM   ENDPT( 4) =    0,500 UM   ENDPT( 5) =    0,600 UM
ENDPT( 6) =    0,800 UM   ENDPT( 7) =    1,000 UM   ENDPT( 8) =    1,200 UM   ENDPT( 9) =    1,400 UM   ENDPT(10) =    1,800 UM


DATA ON CARD NUMBER   8

ENDPT(11) =    2,200 UM   ENDPT(12) =    3,000 UM   ENDPT(13) =    4,000 UM   ENDPT(14) =    6,000 UM   ENDPT(15) =   10,000 UM
ENDPT(16) =   20,000 UM

DATA ON CARD NUMBER   9

PRCU( 1) =   0,0000 %   PRCU( 2) =   0,0002 %   PRCU( 3) =   0,4002 %   PRCU( 4) =   1,0002 %   PRCU( 5) =   2,6672 %
PRCU( 6) =   7,6672 %   PRCU( 7) =  12,6002 %   PRCU( 8) =  17,3332 %   PRCU( 9) =  21,3332 %   PRCU(10) =  29,3332 %


DATA ON CARD NUMBER  10

PRCU(11) =  36,0002 %   PRCU(12) =  46,6672 %   PRCU(13) =  57,3342 %   PRCU(14) =  68,6672 %   PRCU(15) =  80,6672 %
PRCU(16) = 100,0000 %

DATA ON CARD NUMBER  11

NUMSEC =  3    LSECT( 1) =  3  LSECT( 2) =  3  LSECT( 3) =  [illegible]

DATA ON CARD NUMBER  12

AS( 1) =  6,2500E+00 FT**2  VOS( 1) =  4,0000E+04 /  TCS( 1) =  1,5000E+04 A  RLS( 1) =  6,2500E+00 FT
ACS( 1) =  4,6675E+02 IN  RS( 1) =  5,0000E+00 IN  WS( 1) =  5,2000E+00

DATA ON CARD NUMBER  13

BSDS( 1) =  2,5000E+00 IN  VSA( 1) =  5,0000E+02 FT**3/MIN  [illegible]( 1) =  [illegible] FT/SEC  TEMPS( 1) =  7,0000E+01 F
```

```
[illegible] 1) = [illegible] KG/M-SEC  LI-CS( 1) =  8.3333E-01 FT

[illegible]  14

[illegible] 2) = [illegible] FT**2  VDS( 2) =  4.5000E+04 V  TCS( 2) =  1.5000E-04 A  WLS( 2) =  6.2500E+00 FT
[illegible] 2) = [illegible] IN  [illegible]( 2) =  5.0000E+00 IN  [illegible]( 2) =  5.0000E+00

[illegible]  15

[illegible] 2) = [illegible] FT**3/MIN  VGASS( 2) =  8.0000E+00 FT/SEC  TEMPS( 2) =  7.6800E+01 F
[illegible] 2) = [illegible] 1.0000E-05 KG/M-SEC  LINCS( 2) =  8.3333E-01 FT

[illegible]  16

[illegible] 3) = [illegible] FT**2  [illegible]( 3) =  4.4000E+04 V  TCS( 3) =  3.0000E-04 A  WLS( 3) =  1.2500E+01 FT
[illegible] 3) = [illegible] IN  [illegible]( 3) =  1.0000E+01

[illegible]  17

[illegible] 3) = [illegible] FT**3/MIN  VGASS( 3) =  8.0000E+00 FT/SEC  TEMPS( 3) =  7.6800E+01 F
[illegible] 3) = [illegible] 1.0000E-05 KG/M-SEC  LI-CS( 3) =  8.3333E-01 FT
```

```
[illegible]

[illegible]

[illegible] SECTION NO. = 1 AND THE SECTION LENGTH IS =  0.7625 M

[illegible]                        APPLIED VOLTAGE =  4.600E+04 VOLTS       TOTAL CURRENT =  1.500E-04 AMPS
[illegible]                        CORONA WIRE RADIUS =  1.191E-03 M        CORONA WIRE LENGTH =  1.906E+00 M
[illegible]                        CURRENT DENSITY =  2.581E-04 AMP/M2      DEPOSIT E FIELD =  2.581E+03 VOLT/M
[illegible]                        GAS FLOW RATE =  2.305E-01 M3/SEC        GAS VELOCITY =  2.440E+00 M/SEC
[illegible]                        PRESSURE =   1.000 ATM                   VISCOSITY =  1.800E-05 KG/M-SEC
[illegible]                        MEAN THERMAL SPEED =  4.439E+02 M/SEC    PART. PATH PARAM. =  5.708E-08 M
[illegible]                        LENGTH INCR. = .25416565 M               INPUT EFF./INCR. = 31.87

[illegible]  [illegible]  [illegible]  AFID         CMCD    MMD        WEIGHT      DUST LAYER   J(PART)     J(ION)     INCR. NO.

[illegible]  [illegible]  [illegible]  2.0305E+13   25.0    7.69E-06   5.101E-06   3.736E-04    5.31E-08    2.58E-04       1
[illegible]  [illegible]  [illegible]  2.1770E+13   25.0    6.89E-06   7.301E-06   5.347E-04    4.73E-07    2.58E-04       2
[illegible]  [illegible]  [illegible]  2.2010E+13   25.0    3.42E-06   2.510E-06   1.838E-04    6.80E-08    2.58E-04       3

[illegible] SECTION NO. = 2 AND THE SECTION LENGTH IS =  0.7625 M

[illegible]                        APPLIED VOLTAGE =  4.580E+04 VOLTS       TOTAL CURRENT =  1.500E-04 AMPS
[illegible]                        CORONA WIRE RADIUS =  1.191E-03 M        CORONA WIRE LENGTH =  1.906E+00 M
[illegible]                        CURRENT DENSITY =  2.581E-04 AMP/M2      DEPOSIT E FIELD =  2.581E+03 VOLT/M
[illegible]                        GAS FLOW RATE =  2.305E-01 M3/SEC        GAS VELOCITY =  2.440E+00 M/SEC
[illegible]                        PRESSURE =   1.000 ATM                   VISCOSITY =  1.800E-05 KG/M-SEC
[illegible]                        MEAN THERMAL SPEED =  4.439E+02 M/SEC    PART. PATH PARAM. =  5.708E-08 M
[illegible]                        LENGTH INCR. = .25416565 M               INPUT EFF./INCR. = 31.87

[illegible]  [illegible]  [illegible]  AFID         CMCD    MMD        WEIGHT      DUST LAYER   J(PART)     J(ION)     INCR. NO.

[illegible]  [illegible]  [illegible]  2.3590E+13   25.0    3.03E-06   2.054E-06   1.504E-04    6.30E-08    2.58E-04       4
[illegible]  [illegible]  [illegible]  2.4087E+13   25.0    2.72E-06   1.730E-06   1.267E-04    5.95E-08    2.58E-04       5
[illegible]  [illegible]  [illegible]  2.4361E+13   25.0    2.50E-06   1.400E-06   1.088E-04    5.58E-08    2.58E-04       6

[illegible] SECTION NO. = 3 AND THE SECTION LENGTH IS =  1.5250 M

[illegible]                        APPLIED VOLTAGE =  4.440E+04 VOLTS       TOTAL CURRENT =  3.000E-04 AMPS
[illegible]                        CORONA WIRE RADIUS =  1.191E-03 M        CORONA WIRE LENGTH =  3.813E+00 M
[illegible]                        CURRENT DENSITY =  2.581E-04 AMP/M2      DEPOSIT E FIELD =  2.581E+03 VOLT/M
[illegible]                        GAS FLOW RATE =  2.305E-01 M3/SEC        GAS VELOCITY =  2.440E+00 M/SEC
[illegible]                        PRESSURE =   1.000 ATM                   VISCOSITY =  1.800E-05 KG/M-SEC
[illegible]                        MEAN THERMAL SPEED =  4.439E+02 M/SEC    PART. PATH PARAM. =  5.708E-08 M
[illegible]                        LENGTH INCR. = .25416565 M               INPUT EFF./INCR. = 31.87

[illegible]  [illegible]  [illegible]  AFID         CMCD    MMD        WEIGHT      DUST LAYER   J(PART)     J(ION)     INCR. NO.

[illegible]  [illegible]  [illegible]  2.5315E+13   25.0    2.35E-06   1.259E-06   9.220E-05    5.09E-08    2.58E-04       7
[illegible]  [illegible]  [illegible]  2.5430E+13   25.0    2.23E-06   1.108E-06   8.111E-05    4.70E-08    2.58E-04       8
[illegible]  [illegible]  [illegible]  2.5517E+13   25.0    2.12E-06   9.831E-07   7.200E-05    4.50E-08    2.58E-04       9
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[illegible]  [illegible]  [illegible]  [illegible]   25.0  [illegible]  [illegible]  6.432E-05  4.23E-08  2.58E-04   10
[illegible]  [illegible]  [illegible]  [illegible]   25.0  1.43E-06     7.693E-07    5.779E-05  3.99E-08  2.58E-04   11
[illegible]  [illegible]  [illegible]  [illegible]   25.0  1.44E-06     7.122E-07    5.216E-05  3.70E-08  2.58E-04   12

EXP. EFFICIENCY = [illegible]     UNCORRECTED COMPUTED EFFICIENCY = 75.43

INCREMENTAL ANALYSIS OF PRECIPITATOR PERFORMANCE


[illegible]


CALCULATION IS IN SECTION NO. = 1 AND THE SECTION LENGTH IS =  0.7625 M

[illegible]                          APPLIED VOLTAGE =  4.600E+04 VOLTS       TOTAL CURRENT =  1.500E-04 AMPS
[illegible]                          CORONA WIRE RADIUS =  1.191E-03 M        CORONA WIRE LENGTH =  1.906E+00 M
[illegible]                          CURRENT DENSITY =  2.581E-04 AMP/M2      DEPOSIT E FIELD =  2.581E+03 VOLT/M
[illegible]                          GAS FLOW RATE =  2.305E-01 M3/SEC        GAS VELOCITY =  2.440E+00 M/SEC
[illegible]                          PRESSURE =  1.000 ATM                    VISCOSITY =  1.800E-05 KG/M-SEC
[illegible]                          MEAN THERMAL SPEED =  4.439E+02 M/SEC    PART. PATH PARAM. =  5.708E-08 M
[illegible]                          LENGTH INCR. = .2541[illegible] M        INPUT EFF./INCR. = 11.04

[illegible]  [illegible]    EPLT        EFID        CHCD    [illegible]      WEIGHT      DUST LAYER   J(PART)     J(ION)    INCR. NO.

[illegible]  [illegible]  [illegible]  [illegible]   25.0   7.60E-06    5.048E-06    3.697E-04   5.54E-08    2.58E-04      1
[illegible]  [illegible]  [illegible]  [illegible]   25.0   6.91E-06    7.372E-06    5.399E-04   5.07E-07    2.58E-04      2
[illegible]  [illegible]  [illegible]  [illegible]   25.0   3.44E-06    2.518E-06    1.844E-04   6.94E-08    2.58E-04      3

CALCULATION IS IN SECTION NO. = 2 AND THE SECTION LENGTH IS =  0.7625 M

[illegible]                          APPLIED VOLTAGE =  4.580E+04 VOLTS       TOTAL CURRENT =  1.500E-04 AMPS
[illegible]                          CORONA WIRE RADIUS =  1.191E-03 M        CORONA WIRE LENGTH =  1.906E+00 M
[illegible]                          CURRENT DENSITY =  2.581E-04 AMP/M2      DEPOSIT E FIELD =  2.581E+03 VOLT/M
[illegible]                          GAS FLOW RATE =  2.305E-01 M3/SEC        GAS VELOCITY =  2.440E+00 M/SEC
[illegible]                          PRESSURE =  1.000 ATM                    VISCOSITY =  1.800E-05 KG/M-SEC
[illegible]                          MEAN THERMAL SPEED =  4.439E+02 M/SEC    PART. PATH PARAM. =  5.708E-08 M
[illegible]                          LENGTH INCR. = .2541[illegible] M        INPUT EFF./INCR. = 11.04

[illegible]  [illegible]    EPLT        EFID        CHCD    [illegible]      WEIGHT      DUST LAYER   J(PART)     J(ION)    INCR. NO.

[illegible]  [illegible]  [illegible]  [illegible]   25.0   [illegible] 2.067E-06    1.514E-04   6.44E-08    2.58E-04      4
[illegible]  [illegible]  [illegible]  [illegible]   25.0   2.72E-06    1.734E-06    1.273E-04   6.01E-08    2.58E-04      5
[illegible]  [illegible]  [illegible]  [illegible]   25.0   2.50E-06    1.408E-06    1.090E-04   5.62E-08    2.58E-04      6

CALCULATION IS IN SECTION NO. = 3 AND THE SECTION LENGTH IS =  1.5250 M

[illegible]                          APPLIED VOLTAGE =  4.440E+04 VOLTS       TOTAL CURRENT =  3.000E-04 AMPS
[illegible]                          CORONA WIRE RADIUS =  1.191E-03 M        CORONA WIRE LENGTH =  3.813E+00 M
[illegible]                          CURRENT DENSITY =  2.581E-04 AMP/M2      DEPOSIT E FIELD =  2.581E+03 VOLT/M
[illegible]                          GAS FLOW RATE =  2.305E-01 M3/SEC        GAS VELOCITY =  2.440E+00 M/SEC
[illegible]                          PRESSURE =  1.000 ATM                    VISCOSITY =  1.800E-05 KG/M-SEC
[illegible]                          MEAN THERMAL SPEED =  4.439E+02 M/SEC    PART. PATH PARAM. =  5.708E-08 M
[illegible]                          LENGTH INCR. = .2541[illegible] M        INPUT EFF./INCR. = 11.04

[illegible]  [illegible]    EPLT        EFID        CHCD    [illegible]      WEIGHT      DUST LAYER   J(PART)     J(ION)    INCR. NO.
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[illegible]  [illegible]  [illegible]  2,5076E+13   25,8   2,35E-06   1,255E-06   9,192E-05   5,11E-08   2,58E-04    7
[illegible]  [illegible]  [illegible]  2,5171E+13   25,8   2,22E-06   1,104E-06   8,082E-05   4,79E-08   2,58E-04    8
[illegible]  [illegible]  [illegible]  2,5250E+13   25,8   2,12E-06   9,793E-07   7,173E-05   4,50E-08   2,58E-04    9
[illegible]  [illegible]  [illegible]  2,5318E+13   25,8   2,02E-06   8,749E-07   6,407E-05   4,23E-08   2,58E-04   10
[illegible]  [illegible]  [illegible]  2,5371E+13   25,8   1,92E-06   7,861E-07   5,757E-05   3,99E-08   2,58E-04   11
[illegible]  [illegible]  [illegible]  2,5418E+13   25,8   1,84E-06   7,097E-07   5,198E-05   3,76E-08   2,58E-04   12

SECT. EFFICIENCY = 75,43     UNCORRECTED COMPUTED EFFICIENCY = 75,52

INCREMENTAL ANALYSIS OF PRECIPITATOR PERFORMANCE


[illegible]

CALCULATION IS IN SECTION NO. = 1 AND THE SECTION LENGTH IS =  0,7625 M

COLLECTION AREA = [illegible] M2          APPLIED VOLTAGE =  4,600E+04 VOLTS          TOTAL CURRENT =  1,500E-04 AMPS
WIRE TO PLATE = [illegible] M             CORONA WIRE RADIUS =  1,191E-03 M           CORONA WIRE LENGTH =  1,906E+00 M
CURRENT/M = [illegible] AMP/M             CURRENT DENSITY =  2,581E-04 AMP/M2         DEPOSIT E FIELD =  2,581E+03 VOLT/M
1/2 WIRE TO WIRE = [illegible] M          GAS FLOW RATE =  2,365E-01 M3/SEC           GAS VELOCITY =  2,440E+00 M/SEC
TEMPERATURE = [illegible] K               PRESSURE =  1,000 ATM                       VISCOSITY =  1,800E-05 KG/M-SEC
ION MOBILITY = [illegible] M2/VOLT-SEC    MEAN THERMAL SPEED =  4,439E+02 M/SEC       PART. PATH PARAM. =  5,708E-08 M
DUST WEIGHT = [illegible] KG/SEC          LENGTH INCR. = ,25416565 M                  INPUT EFF./INCR. = 11,07

[illegible]  [illegible]   [illegible]   EFID         CHCD    MAD        WEIGHT      DUST LAYER   J(PART)      J(ION)    INCR. NO.

[illegible]  [illegible]  [illegible]  2,3088E+13   25,8   7,60E-06   5,048E-06   3,697E-04   5,54E-08   2,58E-04    1
[illegible]  [illegible]  [illegible]  2,3317E+13   25,8   [illegible]   7,372E-06   5,399E-04   5,07E-07   2,58E-04    2
[illegible]  [illegible]  [illegible]  2,3575E+13   25,8   3,44E-06   2,518E-06   1,844E-04   6,94E-08   2,58E-04    3

CALCULATION IS IN SECTION NO. = 2 AND THE SECTION LENGTH IS =  0,7625 M

COLLECTION AREA = [illegible] M2          APPLIED VOLTAGE =  4,560E+04 VOLTS          TOTAL CURRENT =  1,500E-04 AMPS
WIRE TO PLATE = [illegible] M             CORONA WIRE RADIUS =  1,191E-03 M           CORONA WIRE LENGTH =  1,906E+00 M
CURRENT/M = [illegible] AMP/M             CURRENT DENSITY =  2,581E-04 AMP/M2         DEPOSIT E FIELD =  2,581E+03 VOLT/M
1/2 WIRE TO WIRE = [illegible] M          GAS FLOW RATE =  2,365E-01 M3/SEC           GAS VELOCITY =  2,440E+00 M/SEC
TEMPERATURE = [illegible] K               PRESSURE =  1,000 ATM                       VISCOSITY =  1,800E-05 KG/M-SEC
DUST WEIGHT = [illegible] KG/SEC          [illegible]                                 PART. PATH PARAM. =  5,708E-08 M
                                          LENGTH INCR. = ,25416565 M                  INPUT EFF./INCR. = 11,07

[illegible]  [illegible]   [illegible]   EFID         CHCD    MAD        WEIGHT      DUST LAYER   J(PART)      J(ION)    INCR. NO.

[illegible]  [illegible]  [illegible]  2,3878E+13   25,8   3,04E-06   2,067E-06   1,514E-04   6,44E-08   2,58E-04    4
[illegible]  [illegible]  [illegible]  2,4042E+13   25,8   2,72E-06   1,738E-06   1,273E-04   6,01E-08   2,58E-04    5
[illegible]  [illegible]  [illegible]  2,4176E+13   25,8   2,50E-06   1,488E-06   1,090E-04   5,62E-08   2,58E-04    6

CALCULATION IS IN SECTION NO. = 3 AND THE SECTION LENGTH IS =  1,5250 M

COLLECTION AREA = [illegible] M2          APPLIED VOLTAGE =  4,440E+04 VOLTS          TOTAL CURRENT =  3,000E-04 AMPS
WIRE TO PLATE = [illegible] M             CORONA WIRE RADIUS =  1,191E-03 M           CORONA WIRE LENGTH =  3,813E+00 M
CURRENT/M = [illegible] AMP/M             CURRENT DENSITY =  2,581E-04 AMP/M2         DEPOSIT E FIELD =  2,581E+03 VOLT/M
1/2 WIRE TO WIRE = [illegible] M          GAS FLOW RATE =  2,365E-01 M3/SEC           GAS VELOCITY =  2,440E+00 M/SEC
TEMPERATURE = [illegible] K               PRESSURE =  1,000 ATM                       VISCOSITY =  1,800E-05 KG/M-SEC
ION MOBILITY = [illegible] M2/VOLT-SEC    MEAN THERMAL SPEED =  4,439E+02 M/SEC       PART. PATH PARAM. =  5,708E-08 M
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[illegible] WEIGHT = [illegible]        LENGTH INCR. = .2541[illegible]         INPUT EFF./INCR. = 11.07

[illegible]   [illegible]   [illegible]   [illegible]   CNCD   [illegible]   WEIGHT   DUST LAYER   J(PART)   J(ION)   INCR. NO.

[illegible]  [illegible]  [illegible]  2.5070E+13   25.0   2.35E-06   1.255E-06   9.192E-05   5.11E-08   2.58E-04     7
[illegible]  [illegible]  [illegible]  2.5171E+13   25.0   2.22E-06   1.104E-06   8.082E-05   4.79E-08   2.58E-04     8
[illegible]  [illegible]  [illegible]  2.5250E+13   25.0   2.12E-06   9.794E-07   7.173E-05   4.50E-08   2.58E-04     9
[illegible]  [illegible]  [illegible]  2.5316E+13   25.0   2.02E-06   8.749E-07   6.407E-05   4.23E-08   2.58E-04    10
[illegible]  [illegible]  [illegible]  2.5372E+13   25.0   1.92E-06   7.861E-07   5.757E-05   3.99E-08   2.58E-04    11
[illegible]  [illegible]  [illegible]  2.5410E+13   25.0   1.84E-06   7.097E-07   5.198E-05   3.76E-08   2.58E-04    12

[illegible] EFFICIENCY = 75.52     COMPUTED EFFICIENCY = 75.52     CONVERGES
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CHARGING RATES FOR PARTICLE SIZES FROM SUBROUTINE CHARGE OR CHGSUM

[illegible] THEORY USED FOR PARTICLE CHARGING

INCREMENT NO.     [illegible] FOR INDICATED PARTICLE SIZES

    0,2000E-06    0,3000E-06    0,4500E-06    0,5500E-06    0,7000E-06    0,9000E-06    0,1100E-05    0,1300E-05
 1   1,0360        1,0360        1,0360        1,0360        1.0360        1.0360        1,0360        1,0360
 2   1,4241        1,4255        1,4073        1.3862        1.3563        1.3239        1,2995        1,2815
 3   1,6119        1,5919        1,5567        1.5210        1.4741        1.4253        1,3653        1,3628
 4   1,7286        1,6960        1,6486        1.6030        1.5448        1.4855        1,4422        1,4102
 5   1,8156        1,7718        1,7151        1.6621        1.5957        1.5288        1,4802        1,4442
 6   1,8848        1,8313        1,7671        1.7083        1.6353        1.5624        1,5097        1,4707
 7   1,9376        1,8767        1,8050        1.7419        1.6634        1.5855        1,5292        1,4875
 8   1,9828        1,9155        1,8390        1.7708        1.6876        1.6053        1,5461        1,5022
 9   2,0241        1,9496        1,8680        1.7961        1.7066        1.6228        1,5610        1,5152
10   2,0547        1,9786        1,8937        1.8165        1.7276        1.6364        1,5744        1,5269
11   2,0917        2,0062        1,9167        1.8386        1.7446        1.6525        1,5864        1,5375
12   2,1200        2,0300        1,9376        1.8569        1.7600        1.6653        1,5974        1,5471

    0,1000E-05    0,2000E-05    0,2800E-05    0,3500E-05    0,5000E-05    0,8000E-05    0,1500E-04
 1   1,0327        1,0360        1,0360        1.0360        1.0360        1.0360        1,0360
 2   1,2620        1,2696        1,2400        1.2356        1.2745        2,0196       30,3965
 3   1,3309        1,3120        1,2923        1.2762        1.2865        2.0196       30,3965
 4   1,3763        1,3676        1,3211        1.2980        1.2947        2.0196       30,3965
 5   1,4050        1,3726        1,3417        1.3137        1.3016        2.0196       30,3965
 6   1,4269        1,3922        1,3576        1.3259        1.3074        2.0196       30,3965
 7   1,4429        1,4032        1,3658        1.3313        1.3074        2.0196       30,3965
 8   1,4551        1,4131        1,3731        1.3313        1.3074        2.0196       30,3965
 9   1,4658        1,4219        1,3797        1.3313        1.3074        2.0196       30,3965
10   1,4757        1,4298        1,3797        1.3313        1.3074        2.0196       30,3965
11   1,4844        1,4371        1,3797        1.3313        1.3074        2,0196       30,3965
12   1,4927        1,4437        1,3797        1.3313        1.3074        2,0196       30,3965
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CHARGE ACCUMULATED ON PARTICLE SIZES IN EACH I-CHANNEL?

INCREMENT        CHARGE FOR INDICATED PARTICLE SIZES

       0.2500E-06   0.3500E-06   0.4500E-06   0.5500E-06   0.7000E-06   0.9000E-06   0.1100E-05   0.1300E-05
  1    [illegible]  [illegible]  0.52363E-17  0.75764E-17  0.11922E-16  0.19280E-16  0.28423E-16  0.39355E-16
  2    [illegible]  [illegible]  0.71129E-17  0.10137E-16  0.15600E-16  0.24636E-16  0.35651E-16  0.48676E-16
  3    [illegible]  [illegible]  0.78679E-17  0.11123E-16  0.16963E-16  0.26523E-16  0.38116E-16  0.51766E-16
  4    [illegible]  [illegible]  0.83322E-17  0.11722E-16  0.17777E-16  0.27644E-16  0.39567E-16  0.53568E-16
  5    [illegible]  [illegible]  0.86666E-17  0.12155E-16  0.18363E-16  0.28449E-16  0.40608E-16  0.54860E-16
  6    [illegible]  [illegible]  0.89311E-17  0.12492E-16  0.18819E-16  0.29076E-16  0.41418E-16  0.55864E-16
  7    [illegible]  [illegible]  0.91289E-17  0.12738E-16  0.19142E-16  0.29504E-16  0.41953E-16  0.56505E-16
  8    [illegible]  [illegible]  0.92966E-17  0.12950E-16  0.19420E-16  0.29874E-16  0.42417E-16  0.57063E-16
  9    [illegible]  [illegible]  0.94410E-17  0.13134E-16  0.19664E-16  0.30199E-16  0.42826E-16  0.57557E-16
 10    [illegible]  [illegible]  0.95779E-17  0.13298E-16  0.19881E-16  0.30490E-16  0.43192E-16  0.58000E-16
 11    [illegible]  [illegible]  0.96875E-17  0.13446E-16  0.20076E-16  0.30751E-16  0.43523E-16  0.58401E-16
 12    [illegible]  [illegible]  0.97932E-17  0.13579E-16  0.20253E-16  0.30990E-16  0.43825E-16  0.58768E-16

       0.1500E-05   0.2000E-05   0.2500E-05   0.3500E-05   0.5000E-05   0.8000E-05   0.1500E-04
  1    [illegible]  [illegible]  0.15399E-15  0.27760E-15  0.56449E-15  0.14388E-14  0.50445E-14
  2    [illegible]  [illegible]  0.18431E-15  0.33112E-15  0.69395E-15  0.28047E-14  0.14801E-12
  3    [illegible]  [illegible]  0.19257E-15  0.34195E-15  0.70045E-15  0.28047E-14  0.14801E-12
  4    [illegible]  [illegible]  0.19828E-15  0.34780E-15  0.70494E-15  0.28047E-14  0.14801E-12
  5    [illegible]  [illegible]  0.19961E-15  0.35204E-15  0.70860E-15  0.28047E-14  0.14801E-12
  6    [illegible]  [illegible]  0.20117E-15  0.35527E-15  0.71104E-15  0.28047E-14  0.14801E-12
  7    [illegible]  [illegible]  [illegible]  0.35672E-15  0.71104E-15  0.28047E-14  0.14801E-12
  8    [illegible]  [illegible]  [illegible]  0.35672E-15  0.71104E-15  0.28047E-14  0.14801E-12
  9    [illegible]  [illegible]  [illegible]  0.35672E-15  0.71104E-15  0.28047E-14  0.14801E-12
 10    [illegible]  [illegible]  [illegible]  0.35672E-15  0.71104E-15  0.28047E-14  0.14801E-12
 11    [illegible]  [illegible]  [illegible]  0.35672E-15  0.71104E-15  0.28047E-14  0.14801E-12
 12    [illegible]  [illegible]  [illegible]  0.35672E-15  0.71104E-15  0.28047E-14  0.14801E-12
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[illegible] SIZE [illegible] STATISTICS

CORRECTIONS FOR NONIDEALITIES USING SET NO.  1 OF CORRECTION PARAMETERS

   SIZE      [illegible]  SNEAK % OUTLET % CUM. OUTLET % NO-RAP EFF. NO-RAP W  NO-RAP P  COR. EFF.   COR. W     COR. P
[illegible]  [illegible]  [illegible]      0.0045        53.2436     7.733   46.7564   53.2436    7.733    46.7564
[illegible]  [illegible]  [illegible]      0.9214        53.9203     7.881   46.0797   53.1403    7.711    46.8597
[illegible]  [illegible]  [illegible]      1.8462        55.2681     8.183   44.7319   54.3608    7.979    45.6392
[illegible]  [illegible]  [illegible]      3.5417        57.0170     8.569   42.9830   56.5333    8.475    43.4667
[illegible]  [illegible]  [illegible]     10.1020        59.3795     9.164   40.6205   58.8940    9.043    41.1060
[illegible]  [illegible]  [illegible]      9.2516        62.5468     9.940   37.4532   61.8461    9.801    38.1539
[illegible]  [illegible]  [illegible]      8.2818        65.3206    10.772   34.6794   64.4024   10.507    35.5976
[illegible]  [illegible]  [illegible]      6.3653        67.8767    11.551   32.1233   66.6092   11.158    33.3908
[illegible]  [illegible]  [illegible]     11.9937        71.0384    12.605   28.9616   69.5767   12.104    30.4233
[illegible]  [illegible]  [illegible]      8.9630        74.6469    13.959   25.3531   72.7087   13.209    27.2913
[illegible]  [illegible]  [illegible]     12.2944        78.8771    15.816   21.1229   76.3616   14.671    23.6384
[illegible]  [illegible]  [illegible]     10.2495        83.2481    18.174   16.7519   80.2616   16.505    19.7384
[illegible]  [illegible]  [illegible]      8.5306        89.2903    22.725   10.7097   84.6867   19.087    15.3133
[illegible]  [illegible]  [illegible]      3.4551        99.5193    54.296    0.4807   94.1425   28.863     5.8575
[illegible]  [illegible]  [illegible]      4.2317        99.9999   *******    0.0001   95.4417   31.414     4.5583

EFFICIENCIES FOR CONVERGENCE CHECK:  SUMMED UP PREVIOUS CALCULATION =  75.517   FINAL CALCULATION =  75.518

     ADJUSTED NO-RAP EFF. =  62.7070
     MMD OF INLET SIZE DISTRIBUTION =  3.862E+00
     SIGMAP OF INLET SIZE DISTRIBUTION =  2.104E+00
     LOG-NORMAL GOODNESS OF FIT =  0.935
     MMD OF EFFLUENT UNDER NO-RAP CONDITIONS =  1.579E+00
     SIGMAP OF EFFLUENT UNDER NO-RAP CONDITIONS =  1.092E+00
     LOG-NORMAL GOODNESS OF FIT =  0.958
     PRECIPITATION RATE PARAMETER UNDER NO-RAP CONDITIONS = 17.651

     [illegible]     0.000  WITH  0.000 SNEAKAGE OVER    4.000  STAGES
     [illegible] = 1
     [illegible] =  0.[illegible]
     [illegible] = 2.50
     CORR. EFF. =  75.[illegible]
     CORRECTED MMD OF EFFLUENT =  2.[illegible]E+00
     CORRECTED SIGMAP OF EFFLUENT =  1.[illegible]E+00
     LOG-NORMAL GOODNESS OF FIT =  0.967
     CORRECTED PRECIPITATION RATE PARAMETER =   14.2[illegible]
```

[illegible] MASS LOADINGS

[illegible]	[illegible] EFFICIENCY (%)	NO-RAP DM/DLOGD (MG/DSCM)	RAPPING PUFF DM/DLOGD (MG/DSCM)	NO-RAP+RAP PUFF DM/DLOGD (MG/DSCM)	RAPPING PUFF DISTRIBUTION (%)	PARTICLE DIAM. (M)
[illegible]	[illegible]	1.993E-04	2.836E-03	3.035E-03	4.360E-02	2.500E-07
[illegible]	[illegible]	5.536E-01	9.371E-03	5.630E-01	1.022E-01	3.500E-07
[illegible]	[illegible]	1.638E+00	2.160E-02	1.660E+00	1.784E-01	4.500E-07
[illegible]	[illegible]	3.404E+00	3.021E-02	3.434E+00	2.642E-01	5.500E-07
[illegible]	[illegible]	6.100E+00	7.291E-02	6.173E+00	7.953E-01	7.000E-07
[illegible]	[illegible]	7.154E+00	1.330E-01	7.288E+00	1.132E+00	9.000E-07
[illegible]	[illegible]	7.779E+00	2.060E-01	7.985E+00	1.424E+00	1.100E-06
[illegible]	[illegible]	7.222E+00	2.642E-01	7.487E+00	1.661E+00	1.300E-06
[illegible]	[illegible]	5.964E+00	4.020E-01	6.366E+00	3.031E+00	1.600E-06
[illegible]	[illegible]	7.270E+00	5.564E-01	7.835E+00	4.234E+00	2.000E-06
[illegible]	[illegible]	6.277E+00	7.475E-01	7.025E+00	6.791E+00	2.600E-06
[illegible]	[illegible]	5.367E+00	9.560E-01	6.324E+00	1.044E+01	3.500E-06
[illegible]	[illegible]	2.580E+00	1.117E+00	3.696E+00	1.709E+01	5.000E-06
[illegible]	[illegible]	9.758E-02	1.091E+00	1.189E+00	2.114E+01	8.000E-06
[illegible]	[illegible]	2.413E-04	1.099E+00	1.099E+00	2.887E+01	1.500E-05

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                              E.P.A. ESP MODEL
                          I.E.R.L.-R.T.P. AND SO.R.I.

                        SUMMARY TABLE OF ESP OPERATING
                          PARAMETERS AND PERFORMANCE


                              DATA SET NUMBER   1

                        NON-IDEAL CONDITION SET NUMBER  1

ESP PERFORMANCE:     EFFICIENCY =  79.0962 %     SCA =  9.831E+00 M**2/(M**3/SEC)
                                                        (  50. FT**2/1000 ACFM)

ELECTRICAL CONDITIONS:     AVG. APPLIED VOLTAGE =  4.515E+04 V
                           AVG. CURRENT DENSITY =   25.81 NA/CM**2
                           RESISTIVITY =  1.000E+09 OHM-CM

SIZE DISTRIBUTIONS:     INLET MMD =  3.002E+00 UM      INLET SIGMAP =  2.164E+00
                        OUTLET MMD =  2.088E+00 UM      OUTLET SIGMAP =  1.943E+00

NONIDEAL PARAMETERS:     GAS SNEAKAGE FRACTION =  .00 /SECTION     GAS VELOCITY SIGMAG =  .00
                         RAPPING MMD =  6.000E+00 UM     RAPPING SIGMAP =  2.500E+00
```

```
*****************************************
*                                       *
*          [illegible] MODEL            *
*                                       *
*   [illegible]                         *
*                                       *
*            REVISION III               *
*                                       *
*****************************************

PRINTOUT OF INPUT DATA FOR DATA SET NUMBER  4


DATA ON CARD NUMBER   1

[illegible] = 10   [illegible] =  2   [illegible] =  1   [illegible] =  2   [illegible] =  0   DATUL =  0.00 FT   NCUMPS =  0   NWAVES =  0   WLAMDA =  0

DATA ON CARD NUMBER   2

[illegible]

DATA ON CARD NUMBER   3

[illegible]( 1) =  [illegible] [illegible]   [illegible]( 1) =  [illegible] FT/SEC
[illegible]( 2) =  [illegible] [illegible]   [illegible]( 2) =  [illegible] FT/SEC
[illegible]( 3) =  [illegible] [illegible]   [illegible]( 3) =  [illegible] FT/SEC
```

```
[illegible] STATISTICS

CORRECTIONS FOR [illegible] SET NO.  1 OF CORRECTION PARAMETERS

  SIZE     [illegible]                                          NOMINAL EFF. NOMINAL W  NOMINAL P  CUM. EFF.   CUM. W      CUM. P
[illegible]                                                     97.6842      9.365     2.5156     97.4842     9.365       2.5156
[illegible]                                                     97.6848      9.315     2.5352     97.2800     9.149       2.7392
[illegible]                                                     97.6599      9.549     2.3401     97.4227     9.303       2.5773
[illegible]                                                     97.8602      9.890     2.0396     97.8337     9.745       2.1663
[illegible]                                                     98.3330     10.411     1.6670     98.2060    10.225       1.7940
[illegible]                                                     98.7745     11.196     1.2255     98.5913    10.846       1.4087
[illegible]                                                     99.0888     11.967     0.9112     98.8487    11.353       1.1513
[illegible]                                                     99.3242     12.707     0.6758     98.9928    11.693       1.0072
[illegible]                                                     99.5482     13.731     0.4518     99.1660    12.173       0.8340
[illegible]                                                     99.7242     15.033     0.2758     99.2225    12.351       0.7775
[illegible]                                                     99.8717     16.933     0.1283     99.2141    12.324       0.7859
[illegible]                                                     99.9691     20.553     0.0309     99.1883    12.242       0.8117
[illegible]                                                     99.9999     34.041     0.0001     98.7963    11.240       1.2037
[illegible]                                                     99.9999    140.677     0.0001     98.5943    10.845       1.4057
[illegible]                                                     99.9999    ********    0.0001     98.8083    11.265       1.1917

[illegible] CHECK:  [illegible] PREVIOUS CALCULATION =  97.667   FINAL CALCULATION =  97.865

    [illegible]
    [illegible]
    [illegible]
    [illegible] OF FIT =  0.935
    [illegible]
    [illegible]
    [illegible] OF FIT =  0.963
    [illegible] CONDITIONS = 14.429

    [illegible]
    [illegible]
    [illegible]
    [illegible]
    [illegible]
    [illegible]
    [illegible]
    [illegible] OF FIT =  0.963
    [illegible] =   11.3[illegible]
```

```
*******************************************************************************************
*                                                                                         *
*                              E.P.A. ESP MODEL                                           *
*                        I.E.R.L.-RT.P. AND S.R.I.                                        *
*                                                                                         *
*                      SUMMARY TABLE OF ESP OPERATING                                     *
*                        PARAMETERS AND PERFORMANCE                                       *
*                                                                                         *
*                                                                                         *
*                             DATA SET NUMBER   2                                         *
*                                                                                         *
*                      NONIDEAL CONDITION SET NUMBER  1                                   *
*                                                                                         *
*     ESP PERFORMANCE:    EFFICIENCY =  99.6990 %     SCA =  3.9326E+01 M**2/(M**3/SEC)   *
*                                                      ( 200. FT**2/1000 ACFM)            *
*                                                                                         *
*     ELECTRICAL CONDITIONS:    AVG. APPLIED VOLTAGE =  4.5156E+04 V                      *
*                               AVG. CURRENT DENSITY =   25.01 NA/CM**2                   *
*                               RESISTIVITY =  1.0000E+09 OHM-CM                          *
*                                                                                         *
*     SIZE DISTRIBUTIONS:    INLET MMD =  3.[illegible]E+00 UM     INLET SIGMAP =  4.1648E+00   *
*                            OUTLET MMD =  [illegible] UM     OUTLET SIGMAP =  2.3072E+00       *
*                                                                                         *
*     NONIDEAL PARAMETERS:    GAS SNEAKAGE FRACTION =  .05 /SECTION     GAS VELOCITY SIGMAG =  .00 *
*                             RAPPING MMD =  6.0000E+00 UM     RAPPING SIGMAP =  2.5000E+00 *
*                                                                                         *
*******************************************************************************************
```

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```
*****************************************
*                                       *
*          [illegible]                  *
*                                       *
*          [illegible]                  *
*                                       *
*          [illegible]                  *
*                                       *
*****************************************

[illegible]   2


[illegible]
[illegible]
[illegible]

[illegible]   1

[illegible]

[illegible]   2

[illegible]

[illegible]   3

[illegible]
[illegible]
[illegible]
```

PARTICLE SIZE RANGE STATISTICS

```
CORRECTIONS FOR NONIDEALITIES USING SET NO.  1 OF CORRECTION PARAMETERS

   SIZE     CCF  INLET % OUTLET % COR. OUTLET % NO-RAP EFF. NO-RAP W  NO-RAP P  COR. EFF.   COR. W     COR. P
 2,500E-07  1,590  0,000   0,0021        0,0396     99,7005     9,851   0,2995   40,8180    0,869    59,1820
 3,500E-07  1,414  0,400   4,3450        0,5103     99,6878     9,781   0,3122   99,6188    9,442     0,3812
 4,500E-07  1,320  0,600   5,8708        0,7259     99,7188     9,958   0,2812   99,6385    9,532     0,3615
 5,500E-07  1,261  1,667  13,3752        1,5252     99,7694    10,294   0,2306   99,7266   10,006     0,2734
 7,000E-07  1,205  5,000  29,6386        3,5889     99,8285    10,796   0,1715   99,7855   10,417     0,2145
 9,000E-07  1,159  4,933  16,5879        2,8115     99,8917    11,576   0,1083   99,8297   10,808     0,1703
 1,100E-06  1,130  4,733  11.4229        2,3857     99,9306    12,331   0,0694   99,8494   11.017     0,1506
 1,300E-06  1,110  4,000   6.1413        2.0922     99,9559    13,098   0,0441   99,8437   10,954     0,1563
 1,600E-06  1,090  8,000   6,6803        4.1055     99,9760    14.130   0,0240   99,8467   10,986     0,1533
 2,000E-06  1,072  6,667   2,5245        4,0696     99,9891    15.471   0,0109   99,8176   10,692     0,1824
 2,600E-06  1,055 10,667   1.0257        8,0451     99,9972    17,795   0,0028   99,7746   10.333     0,2254
 3,500E-06  1,041 10,667   0,0372        9.4444     99,9999    21,663   0,0001   99,7354   10,061     0,2646
 5,000E-06  1,029 11,333   0,0395       15,4505     99,9999    43,167   0,0001   99,5926    9,330     0,4074
 8,000E-06  1,018 12,000   0,0418       19,1081     99,9999   198,337   0,0001   99,5242    9,066     0,4756
 1,500E-05  1,010 19,333   0,0674       26,0975     99,9999   *******   0,0001   99,5966    9,346     0,4034

EFFICIENCIES FOR CONVERGENCE CHECK:  STATED OR PREVIOUS CALCULATION =  99,479   FINAL CALCULATION =  99,479


   ADJUSTED NO-RAP EFF. =  99,9713
   MMD OF INLET SIZE DISTRIBUTION =  3,302E+00
   SIGMAP OF INLET SIZE DISTRIBUTION =  2,164E+00
   LOG-NORMAL GOODNESS OF FIT =  0,935
   MMD OF EFFLUENT UNDER NO-RAP CONDITIONS =  8,741E-01
   SIGMAP OF EFFLUENT UNDER NO-RAP CONDITIONS =  1,428E+00
   LOG-NORMAL GOODNESS OF FIT =  0,970
   PRECIPITATION RATE PARAMETER UNDER NO-RAP CONDITIONS = 13,825


   SIGMAG=    0,000  WITH  0,000 SNEAKAGE OVER    4,000  STAGES
   NTEMP = 1
   RMMD =  6,00
   RSIGMA = 2,50
   CORR. EFF. =  99,7012
   CORRECTED MMD OF EFFLUENT =  4,728E+00
   CORRECTED SIGMAP OF EFFLUENT =  2,702E+00
   LOG-NORMAL GOODNESS OF FIT =  0,980
   CORRECTED PRECIPITATION RATE PARAMETER =    9,86
```

```
****************************************************************************************************
*                                                                                                  *
*                                      E.P.A. ESP MODEL                                            *
*                                I.E.R.L.-R.T.P. AND SO.R.I.                                       *
*                                                                                                  *
*                                SUMMARY TABLE OF ESP OPERATING                                    *
*                                 PARAMETERS AND PERFORMANCE                                       *
*                                                                                                  *
*                                                                                                  *
*                                     DATA SET NUMBER   3                                          *
*                                                                                                  *
*                                NON-IDEAL CONDITION SET NUMBER  1                                 *
*                                                                                                  *
*       ESP PERFORMANCE:     EFFICIENCY =  99.7012 %     SCA =  5.899E+01 M**2/(M**3/SEC)          *
*                                                               ( 300. FT**2/1000 ACFM)            *
*                                                                                                  *
*       ELECTRICAL CONDITIONS:     AVG. APPLIED VOLTAGE =  4.515E+04 V                             *
*                                  AVG. CURRENT DENSITY =   25.81 NA/CM**2                         *
*                                  RESISTIVITY =  1.000E+09 OHM-CM                                 *
*                                                                                                  *
*       SIZE DISTRIBUTIONS:     INLET MMD =  3.302E+00 UM     INLET SIGMAP =  2.164E+00            *
*                               OUTLET MMD =  4.726E+00 UM     OUTLET SIGMAP =  2.702E+00          *
*                                                                                                  *
*       NONIDEAL PARAMETERS:     GAS SNEAKAGE FRACTION =  .00 /SECTION     GAS VELOCITY SIGMAG =  .00
*                                RAPPING MMD =  6.000E+00 UM     RAPPING SIGMAP =  2.500E+00       *
*                                                                                                  *
****************************************************************************************************
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*************************************
*                                   *
*         E.P.A. ESP MODEL          *
*                                   *
*    I.E.R.L.-R.T.P. AND SO.R.I.    *
*                                   *
*          REVISION III             *
*                                   *
*************************************

PRINTOUT OF INPUT DATA FOR DATA SET NUMBER  4


>>>>> CHECK VALUE OF VGS( 1)

>>>>> CHECK VALUE OF VGS( 2)

>>>>> CHECK VALUE OF VGS( 3)

DATA ON CARD NUMBER   1

NENDPT = 16   NDATA =  3   NRAP =  0   MODL =  0   NOPRNT =  0   PATHL =  0.00 FT   NCOMPS =  0   NWAVES =  0  NLAMDA =  0

DATA ON CARD NUMBER   2

LAB ESP: SCA=400FT2/1000ACFM;J=24UA/FT2

DATA ON CARD NUMBER   3

VGS( 1) =  6.2500E+01 FT**3/MIN  VGASS( 1) =  1.0000E+00 FT/SEC
VGS( 2) =  6.2500E+01 FT**3/MIN  VGASS( 2) =  1.0000E+00 FT/SEC
VGS( 3) =  6.2500E+01 FT**3/MIN  VGASS( 3) =  1.0000E+00 FT/SEC
```

```
PARTICLE SIZE RANGE STATISTICS

CORRECTIONS FOR NONIDEALITIES USING SET NO.  1 OF CORRECTION PARAMETERS

  SIZE       CCF   INLET % OUTLET % COR. OUTLET % NO-RAP EFF. NO-RAP W  NO-RAP P  COR. EFF.   COR. W     COR. P
2.500E-07  1.590  0.000   0.0027        0.0423      99.9671    10.196    0.0329   80.3816     2.071    19.6184
3.500E-07  1.414  0.400   5.7872        0.2526      99.9644    10.095    0.0356   99.9414     9.463     0.0586
4.500E-07  1.320  0.600   7.6259        0.3752      99.9687    10.260    0.0313   99.9420     9.476     0.0580
5.500E-07  1.261  1.667  16.2830        0.6882      99.9759    10.595    0.0241   99.9617    10.004     0.0383
7.000E-07  1.205  5.000  32.6112        1.6413      99.9838    11.100    0.0162   99.9695    10.295     0.0305
9.000E-07  1.159  4.933  17.3221        1.5566      99.9914    11.895    0.0086   99.9707    10.345     0.0293
1.100E-06  1.130  4.733   9.0209        1.6163      99.9953    12.672    0.0047   99.9683    10.243     0.0317
1.300E-06  1.110  4.000   4.1240        1.7162      99.9975    13.454    0.0025   99.9601     9.953     0.0399
1.600E-06  1.090  8.000   3.5773        3.8050      99.9989    14.516    0.0011   99.9559     9.824     0.0441
2.000E-06  1.072  6.667   0.8440        4.6550      99.9997    12.039    0.0003   99.9352     9.335     0.0648
2.600E-06  1.055 10.667   0.4336        8.5551      99.9999    15.932    0.0001   99.9256     9.159     0.0744
3.500E-06  1.041 10.667   0.4336       10.1077      99.9999    24.641    0.0001   99.9121     8.947     0.0879
5.000E-06  1.029 11.333   0.4607       16.5530      99.9999    51.672    0.0001   99.8645     8.397     0.1355
8.000E-06  1.018 12.000   0.4678       20.4715      99.9999   255.981    0.0001   99.8417     6.199     0.1583
1.500E-05  1.010 19.333   0.7859       27.9599      99.9999   *******    0.0001   99.8658     8.409     0.1342

EFFICIENCIES FOR CONVERGENCE CHECK:  STATED OR PREVIOUS CALCULATION =  99.866   FINAL CALCULATION =  99.866


  ADJUSTED NO-RAP EFF. =  99.9975
  MMD OF INLET SIZE DISTRIBUTION =  3.302E+00
  SIGMAP OF INLET SIZE DISTRIBUTION =  2.164E+00
  LOG-NORMAL GOODNESS OF FIT =  0.935
  MMD OF EFFLUENT UNDER NO-RAP CONDITIONS =  9.235E-01
  SIGMAP OF EFFLUENT UNDER NO-RAP CONDITIONS =  1.723E+00
  LOG-NORMAL GOODNESS OF FIT =  0.898
  PRECIPITATION RATE PARAMETER UNDER NO-RAP CONDITIONS = 13.492


  SIGMAG=    0.000  WITH  0.000 SNEAKAGE OVER    4.000  STAGES
  NTEMP = 1
  RMMD =  6.00
  RSIGMA = 2.50
  CORR. EFF. =  99.9072
  CORRECTED MMD OF EFFLUENT =  5.552E+00
  CORRECTED SIGMAP OF EFFLUENT =  2.607E+00
  LOG-NORMAL GOODNESS OF FIT =  0.995
  CORRECTED PRECIPITATION RATE PARAMETER =     8.88
```

```
*******************************************************************************************
*                                                                                         *
*                                    E.P.A. ESP MODEL                                     *
*                              I.E.R.L.-R.T.P. AND SO.R.I.                                *
*                                                                                         *
*                            SUMMARY TABLE OF ESP OPERATING                               *
*                              PARAMETERS AND PERFORMANCE                                 *
*                                                                                         *
*                                                                                         *
*                                  DATA SET NUMBER    4                                   *
*                                                                                         *
*                           NON-IDEAL CONDITION SET NUMBER  1                             *
*                                                                                         *
*   ESP PERFORMANCE:     EFFICIENCY =  99.9072 %     SCA =  7.865E+01 M**2/(M**3/SEC)     *
*                                                          ( 400. FT**2/1000 ACFM)        *
*                                                                                         *
*   ELECTRICAL CONDITIONS:    AVG. APPLIED VOLTAGE =  4.515E+04 V                         *
*                             AVG. CURRENT DENSITY =   25.81 NA/CM**2                     *
*                             RESISTIVITY =  1.000E+09 OHM-CM                             *
*                                                                                         *
*   SIZE DISTRIBUTIONS:     INLET MMD =  3.302E+00 UM      INLET SIGMAP =  2.164E+00      *
*                           OUTLET MMD =  5.552E+00 UM     OUTLET SIGMAP =  2.607E+00     *
*                                                                                         *
*   NONIDEAL PARAMETERS:    GAS SNEAKAGE FRACTION =  .00 /SECTION     GAS VELOCITY SIGMAG =  .00   *
*                           RAPPING MMD =  6.000E+00 UM     RAPPING SIGMAP =  2.500E+00   *
*                                                                                         *
*******************************************************************************************
```

```
                    ************************************
                    *                                  *
                    *        E.P.A. ESP MODEL          *
                    *                                  *
                    *   I.E.R.L.-R.T.P. AND SO.R.I.    *
                    *                                  *
                    *         REVISION III             *
                    *                                  *
                    ************************************

PRINTOUT OF INPUT DATA FOR DATA SET NUMBER  5


>>>>> CHECK VALUE OF VGS( 1)
>>>>> CHECK VALUE OF VGASS( 1)
>>>>> CHECK VALUE OF VGS( 2)
>>>>> CHECK VALUE OF VGASS( 2)
>>>>> CHECK VALUE OF VGS( 3)
>>>>> CHECK VALUE OF VGASS( 3)

 DATA ON CARD NUMBER   1

 NENDPT = 16   NDATA =  3   NRAP =  0   MODL =  0   NOPRNT =  0   PATHL =  0.00 FT   NCOMPS =  0   NWAVES =  0  NLAMDA =  0

 DATA ON CARD NUMBER   2

 LAB ESP; SCA=600FT2/1000ACFM;J=240A/FT2

 DATA ON CARD NUMBER   3

 VGS( 1) =  4.1667E+01 FT**3/MIN  VGASS( 1) =  6.6667E-01 FT/SEC
 VGS( 2) =  4.1667E+01 FT**3/MIN  VGASS( 2) =  6.6667E-01 FT/SEC
 VGS( 3) =  4.1667E+01 FT**3/MIN  VGASS( 3) =  6.6667E-01 FT/SEC
```

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PARTICLE SIZE RANGE STATISTICS

CORRECTIONS FOR NONIDEALITIES USING SET NO.  1 OF CORRECTION PARAMETERS

  SIZE      CCF  INLET % OUTLET % COR. OUTLET % NO-RAP EFF. NO-RAP W  NO-RAP P  COR. EFF.   COR. W     COR. P
2.500E-07  1.590  0.000   0.0006       0.0370       99.9997      5.209    0.0003    95.1003    2.557      4.6997
3.500E-07  1.414  0.400   1.4383       2.5532       99.9996      5.439    0.0004    99.8311    5.411      0.1689
4.500E-07  1.320  0.600   1.7392       2.6119       99.9997      5.764    0.0003    99.6648    5.736      0.1152
5.500E-07  1.261  1.667   3.0736       4.5220       99.9998      6.178    0.0002    99.9262    6.137      0.0716
7.000E-07  1.205  5.000   4.8159       6.7390       99.9999      6.815    0.0001    99.9643    6.729      0.0357
9.000E-07  1.159  4.933   4.7513       3.3307       99.9999      7.589    0.0001    99.9821    7.315      0.0179
1.100E-06  1.130  4.733   4.5587       1.9182       99.9999      8.531    0.0001    99.9893    7.748      0.0107
1.300E-06  1.110  4.000   3.8527       1.5669       99.9999      9.442    0.0001    99.9896    7.776      0.0104
1.600E-06  1.090  8.000   7.7054       3.1667       99.9999     11.194    0.0001    99.9895    7.768      0.0105
2.000E-06  1.072  6.667   6.4215       3.4403       99.9999     13.693    0.0001    99.9863    7.543      0.0137
2.600E-06  1.055 10.667  10.2742       7.1396       99.9999     19.060    0.0001    99.9823    7.323      0.0177
3.500E-06  1.041 10.667  10.2742       8.4762       99.9999     30.612    0.0001    99.9790    7.177      0.0210
5.000E-06  1.029 11.333  10.9156      13.8815       99.9999     66.722    0.0001    99.9676    6.811      0.0324
6.000E-06  1.018 12.000  11.5581      17.1673       99.9999    171.536    0.0001    99.9621    6.679      0.0379
1.500E-05  1.010 19.333  18.6208      23.4475       99.9999    *******    0.0001    99.9679    6.819      0.0321

EFFICIENCIES FOR CONVERGENCE CHECK:  STATED OR PREVIOUS CALCULATION =  99.991   FINAL CALCULATION =  99.991

   ADJUSTED NO-RAP EFF. =  99.9999
   MMD OF INLET SIZE DISTRIBUTION =  3.302E+00
   SIGMAP OF INLET SIZE DISTRIBUTION =  2.164E+00
   LOG-NORMAL GOODNESS OF FIT =  0.935
   MMD OF EFFLUENT UNDER NO-RAP CONDITIONS =  3.118E+00
   SIGMAP OF EFFLUENT UNDER NO-RAP CONDITIONS =  2.352E+00
   LOG-NORMAL GOODNESS OF FIT =  0.917
   PRECIPITATION RATE PARAMETER UNDER NO-RAP CONDITIONS = 11.678


   SIGMAG=    0.000  WITH  0.000 SNEAKAGE OVER    4.000  STAGES
   NTEMP = 1
   RMMD =  6.00
   RSIGMA = 2.50
   CORR. EFF. =  99.9735
   CORRECTED MMD OF EFFLUENT =  3.790E+00
   CORRECTED SIGMAP OF EFFLUENT =  3.076E+00
   LOG-NORMAL GOODNESS OF FIT =  0.926
   CORRECTED PRECIPITATION RATE PARAMETER =    6.94
```

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                              E.P.A. ESP MODEL
                         I.E.R.L.-R.T.P. AND SO.R.I.

                        SUMMARY TABLE OF ESP OPERATING
                          PARAMETERS AND PERFORMANCE


                              DATA SET NUMBER   5

                        NON-IDEAL CONDITION SET NUMBER  1

ESP PERFORMANCE:     EFFICIENCY =  99.9735 %     SCA =  1.180E+02 M**2/(M**3/SEC)
                                                       ( 599. FT**2/1000 ACFM)

ELECTRICAL CONDITIONS:     AVG. APPLIED VOLTAGE =  4.515E+04 V
                           AVG. CURRENT DENSITY =   25.81 NA/CM**2
                           RESISTIVITY =  1.000E+09 OHM-CM

SIZE DISTRIBUTIONS:     INLET MMD =  3.302E+00 UM     INLET SIGMAP =  2.184E+00
                        OUTLET MMD =  3.790E+00 UM     OUTLET SIGMAP =  3.076E+00

NONIDEAL PARAMETERS:     GAS SNEAKAGE FRACTION =  .00 /SECTION     GAS VELOCITY SIGMAG =  .00
                         RAPPING MMD =  6.000E+00 UM     RAPPING SIGMAP =  2.500E+00
```

```
          ****************************************
          *                                      *
          *          E.P.A. ESP MODEL            *
          *     I.E.R.L.-R.T.P. AND SO.R.I.      *
          *            REVISION III              *
          *                                      *
          ****************************************

PRINTOUT OF INPUT DATA FOR DATA SET NUMBER  0

>>>>> CHECK VALUE OF VGS( 1)
>>>>> CHECK VALUE OF VGASS( 1)
>>>>> CHECK VALUE OF VGS( 2)
>>>>> CHECK VALUE OF VGASS( 2)
>>>>> CHECK VALUE OF VGS( 3)
>>>>> CHECK VALUE OF VGASS( 3)

 DATA ON CARD NUMBER   1

 NENDPT = 16   NDATA =  3   NRAP =  0   NUBL =  0   NOPRNT =  0   PATHL =  0.00 FT   NCOMPS =  0   NWAVES =  0  NLAMDA =  0

 DATA ON CARD NUMBER   2

 LAB ESP: SCA=600FT2/1000ACFM;J=240A/FT2

 DATA ON CARD NUMBER   3

 VGS( 1) =  3.1250E+01 FT**3/MIN  VGASS( 1) =  5.0000E-01 FT/SEC
 VGS( 2) =  3.1250E+01 FT**3/MIN  VGASS( 2) =  5.0000E-01 FT/SEC
 VGS( 3) =  3.1250E+01 FT**3/MIN  VGASS( 3) =  5.0000E-01 FT/SEC
```

```
PARTICLE SIZE RANGE STATISTICS

CORRECTIONS FOR NONIDEALITIES USING SET NO.  1 OF CORRECTION PARAMETERS

   SIZE      CCF   INLET %  OUTLET % COR. OUTLET % NO-RAP EFF. NO-RAP W  NO-RAP P  COR. EFF.   COR. W     COR. P
2.500E-07  1.590  0.000    0.0002       0.0433     99.9999     5.377    0.0001    95.3706    1.954     4.6294
3.500E-07  1.414  0.400    0.4000       0.3693     99.9999     5.626    0.0001    99.9802    5.423     0.0198
4.500E-07  1.320  0.600    0.6000       0.3943     99.9999     6.015    0.0001    99.9859    5.639     0.0141
5.500E-07  1.261  1.667    1.6670       0.5927     99.9999     6.398    0.0001    99.9924    6.029     0.0076
7.000E-07  1.205  5.000    5.0000       1.1348     99.9999     7.064    0.0001    99.9951    6.315     0.0049
9.000E-07  1.159  4.933    4.9330       1.1666     99.9999     8.289    0.0001    99.9949    6.287     0.0051
1.100E-06  1.130  4.733    4.7330       1.4136     99.9999     9.517    0.0001    99.9936    6.140     0.0064
1.300E-06  1.110  4.000    4.0000       1.6415     99.9999    10.779    0.0001    99.9912    5.938     0.0088
1.600E-06  1.090  8.000    8.0000       3.7843     99.9999    12.819    0.0001    99.9899    5.848     0.0101
2.000E-06  1.072  8.667    8.6670       4.1814     99.9999    15.987    0.0001    99.9866    5.668     0.0134
2.600E-06  1.055 10.667   10.6670       8.0838     99.9999    22.196    0.0001    99.9826    5.503     0.0174
3.500E-06  1.041 10.667   10.6670      10.3091     99.9999    36.585    0.0001    99.9793    5.394     0.0207
5.000E-06  1.029 11.333   11.3330      16.8839     99.9999    85.776    0.0001    99.9681    5.118     0.0319
8.000E-06  1.018 12.000   12.0000      20.6808     99.9999   487.100    0.0001    99.9628    5.020     0.0372
1.500E-05  1.010 19.333   19.3328      28.5185     99.9999   *******    0.0001    99.9684    5.125     0.0316

EFFICIENCIES FOR CONVERGENCE CHECK:  STATED OR PREVIOUS CALCULATION =  99.991   FINAL CALCULATION =  99.999


   ADJUSTED NO-RAP EFF. =  99.9999
   MMD OF INLET SIZE DISTRIBUTION =  3.302E+00
   SIGMAP OF INLET SIZE DISTRIBUTION =  2.164E+00
   LOG-NORMAL GOODNESS OF FIT =  0.935
   MMD OF EFFLUENT UNDER NO-RAP CONDITIONS =  3.302E+00
   SIGMAP OF EFFLUENT UNDER NO-RAP CONDITIONS =  2.164E+00
   LOG-NORMAL GOODNESS OF FIT =  0.935
   PRECIPITATION RATE PARAMETER UNDER NO-RAP CONDITIONS =  8.762


   SIGMAG=    0.000  WITH  0.000 SNEAKAGE OVER    4.000  STAGES
   NTEMP = 1
   RMMD =  6.00
   RSIGMA = 2.50
   CORR. EFF. =  99.9786
   CORRECTED MMD OF EFFLUENT =  5.887E+00
   CORRECTED SIGMAP OF EFFLUENT =  2.863E+00
   LOG-NORMAL GOODNESS OF FIT =  0.995
   CORRECTED PRECIPITATION RATE PARAMETER =    5.37
```

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****************************************************************************************

                                E.P.A. ESP MODEL
                          I.E.R.L.-R.T.P. AND SO.R.I.

                         SUMMARY TABLE OF ESP OPERATING
                           PARAMETERS AND PERFORMANCE


                               DATA SET NUMBER   6

                         NON-IDEAL CONDITION SET NUMBER  1

ESP PERFORMANCE:     EFFICIENCY =  99.9786 %     SCA =  1.573E+02 M**2/(M**3/SEC)
                                                       ( 799. FT**2/1000 ACFM)

ELECTRICAL CONDITIONS:     AVG. APPLIED VOLTAGE =  4.515E+04 V
                           AVG. CURRENT DENSITY =   25.81 NA/CM**2
                           RESISTIVITY =  1.000E+09 OHM-CM

SIZE DISTRIBUTIONS:     INLET MMD =  3.302E+00 UM     INLET SIGMAP =  2.164E+00
                        OUTLET MMD =  5.887E+00 UM     OUTLET SIGMAP =  2.663E+00

NONIDEAL PARAMETERS:     GAS SNEAKAGE FRACTION =  .00 /SECTION     GAS VELOCITY SIGMAG =  .00
                         RAPPING MMD =  6.000E+00 UM     RAPPING SIGMAP =  2.500E+00

****************************************************************************************
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APPENDIX I

OUTPUT DATA FROM EXAMPLE 9

```
                 ***********************************
                 *                                 *
                 *         E.P.A. ESP MODEL        *
                 *                                 *
                 *    I.E.R.L.-R.T.P. AND SO.R.I.  *
                 *                                 *
                 *          REVISION III           *
                 *                                 *
                 ***********************************

 PRINTOUT OF INPUT DATA FOR DATA SET NUMBER  1


>>>>> CHECK VALUE OF DL

>>>>> CHECK VALUE OF AS( 1)

>>>>> CHECK VALUE OF TEMPS( 1)

>>>>> CHECK VALUE OF TCS( 1)

>>>>> CHECK VALUE OF AS( 2)

>>>>> CHECK VALUE OF TEMPS( 2)

>>>>> CHECK VALUE OF TCS( 2)

>>>>> CHECK VALUE OF TEMPS( 3)

>>>>> CHECK VALUE OF TCS( 3)

 DATA ON CARD NUMBER   1

 NENDPT = 16   NDATA =  1   NRAP =  0   NODL =  0   NOPRNT =  0   PATHL =  0.00 FT   NCOMPS =  0   NWAVES =  0  NLAMDA =  0

 DATA ON CARD NUMBER   2

 LAB ESP: SCA=125FT2/1000ACFM;J=2 NA/CM2

 DATA ON CARD NUMBER   3

 NEST =  1  NDIST =  1  NVI =  1  NX = 10  NY = 10  NITER =  3  NCALC =  0  NRAPD =  1  NEFF =  1  NTEMP =  1  NUMID =  1

 DATA ON CARD NUMBER   4

 NN =  5

 DATA ON CARD NUMBER   5
```

```
DL =  0.01500 GRN/ACF  PL =  10.0000 FT  ETAU = 99.00000 %  PD =  1000.00 KG/M**3  EPS =  5.100E+00
VRATIO =   1.0300  US =  .000165 M**2/V-SEC  FPATH =   1.0000  EBD = 1500000. V/M  RHOCGS =  1.00E+09 OHM-CM

DATA ON CARD NUMBER   6

ASNUCK( 1) =  .00  AZIGGY( 1) =  .00  AZNUMS( 1) =  4.0


DATA ON CARD NUMBER   7

ENDPT( 1) =    0.200 UM   ENDPT( 2) =    0.300 UM   ENDPT( 3) =    0.400 UM   ENDPT( 4) =    0.500 UM   ENDPT( 5) =    0.600 UM
ENDPT( 6) =   0.800 UM   ENDPT( 7) =    1.000 UM   ENDPT( 8) =    1.200 UM   ENDPT( 9) =    1.400 UM   ENDPT(10) =    1.800 UM


DATA ON CARD NUMBER   8

ENDPT(11) =    2.200 UM   ENDPT(12) =    3.000 UM   ENDPT(13) =    4.000 UM   ENDPT(14) =    6.000 UM   ENDPT(15) =   10.000 UM
ENDPT(16) =   20.000 UM

DATA ON CARD NUMBER   9

PRCU( 1) =   0.0000 %   PRCU( 2) =   0.0002 %   PRCU( 3) =   0.4002 %   PRCU( 4) =   1.0002 %   PRCU( 5) =   2.6672 %
PRCU( 6) =   7.6672 %   PRCU( 7) =  12.6002 %   PRCU( 8) =  17.3332 %   PRCU( 9) =  21.3332 %   PRCU(10) =  29.3332 %


DATA ON CARD NUMBER  10

PRCU(11) =  36.0002 %   PRCU(12) =  46.6672 %   PRCU(13) =  57.3342 %   PRCU(14) =  68.6672 %   PRCU(15) =  80.6672 %
PRCU(16) = 100.0000 %

DATA ON CARD NUMBER  11

NUMSEC =  3    LSECT( 1) =  3  LSECT( 2) =  3  LSECT( 3) =  0

DATA ON CARD NUMBER  12

AS( 1) =  6.2500E+00 FT**2  VOS( 1) =  3.7500E+04 V  TCS( 1) =  1.1628E-05 A  WLS( 1) =  6.2500E+00 FT
ACS( 1) =  4.6875E-02 IN  BS( 1) =  5.0000E+00 IN  NWS( 1) =  5.0000E+00
```

```
DATA ON CARD NUMBER  13

SYS( 1) =  2.5000E+00 IN  VGS( 1) =  2.0000E+02 FT**3/MIN  VGASS( 1) =  3.2000E+00 FT/SEC  TEMPS( 1) =  7.6800E+01 F

PS( 1) =  1.0000E+00 ATM  VISS( 1) =  1.8000E-05 KG/M-SEC  LINCS( 1) =  8.3333E-01 FT

DATA ON CARD NUMBER  14

AS( 2) =  6.2500E+00 FT**2  VOS( 2) =  3.7000E+04 V  TCS( 2) =  1.1628E-05 A  WLS( 2) =  6.2500E+00 FT

ACS( 2) =  4.6875E-02 IN  BS( 2) =  5.0000E+00 IN  NWS( 2) =  5.0000E+00

DATA ON CARD NUMBER  15

SYS( 2) =  2.5000E+00 IN  VGS( 2) =  2.0000E+02 FT**3/MIN  VGASS( 2) =  3.2000E+00 FT/SEC  TEMPS( 2) =  7.6800E+01 F

PS( 2) =  1.0000E+00 ATM  VISS( 2) =  1.8000E-05 KG/M-SEC  LINCS( 2) =  8.3333E-01 FT

DATA ON CARD NUMBER  16

AS( 3) =  1.2500E+01 FT**2  VOS( 3) =  3.4900E+04 V  TCS( 3) =  2.3256E-05 A  LS( 3) =  1.2500E+01 FT

ACS( 3) =  4.6875E-02 IN  BS( 3) =  5.0000E+00 IN  NWS( 3) =  1.0000E+01

DATA ON CARD NUMBER  17

SYS( 3) =  2.5000E+00 IN  VGS( 3) =  2.0000E+02 FT**3/MIN  VGASS( 3) =  3.2000E+00 FT/SEC  TEMPS( 3) =  7.6800E+01 F

PS( 3) =  1.0000E+00 ATM  VISS( 3) =  1.8000E-05 KG/M-SEC  LINCS( 3) =  8.3333E-01 FT
```

```
INCREMENTAL ANALYSIS OF PRECIPITATOR PERFORMANCE


LAB ESP: SCA=125FT2/1000ACFM;J=2 NA/CM2

CALCULATION IS IN SECTION NO. = 1 AND THE SECTION LENGTH IS =  0,7625 M

COLLECTION AREA =  5,813E-01 M2        APPLIED VOLTAGE =  3,750E+04 VOLTS       TOTAL CURRENT =  1,163E-05 AMPS
WIRE TO PLATE =  1,270E-01 M           CORONA WIRE RADIUS =  1,191E-03 M        CORONA WIRE LENGTH =  1,906E+00 M
CURRENT/M =  6,100E-06 AMP/M           CURRENT DENSITY =  2,001E-05 AMP/M2      DEPOSIT E FIELD =  2,001E+02 VOLT/M
1/2 WIRE TO WIRE =  6,350E-02 M        GAS FLOW RATE =  9,460E-02 M3/SEC        GAS VELOCITY =  9,760E-01 M/SEC
TEMPERATURE = 297,667 K                PRESSURE =   1,000 ATM                   VISCOSITY =  1,800E-05 KG/M-SEC
ION MOBILITY =  1,798E-04 M2/VOLT-SEC  MEAN THERMAL SPEED =  4,439E+02 M/SEC    PART. PATH PARAM. =  5,708E-08 M
DUST WEIGHT =  3,250E-06 KG/SEC        LENGTH INCR. = ,25416565 M               INPUT EFF./INCR. = 31,67

ROVRI     ERAVG       EPLT        AFID       CMCD      MMD        WEIGHT     DUST LAYER   J(PART)      J(ION)   INCR. NO.

1,9041   2,953E+05  1,8373E+05  1,2368E+12    2,0   7,69E-06   1,850E-06   5,421E-05   1,88E-09    2,00E-05       1
1,6010   2,953E+05  1,8284E+05  1,4710E+12    2,0   7,34E-06   2,941E-06   8,617E-05   5,35E-09    2,00E-05       2
1,3927   2,953E+05  1,8170E+05  1,6910E+12    2,0   6,87E-06   3,553E-06   1,041E-04   9,66E-09    2,00E-05       3

CALCULATION IS IN SECTION NO. = 2 AND THE SECTION LENGTH IS =  0,7625 M

COLLECTION AREA =  5,813E-01 M2        APPLIED VOLTAGE =  3.700E+04 VOLTS       TOTAL CURRENT =  1,163E-05 AMPS
WIRE TO PLATE =  1,270E-01 M           CORONA WIRE RADIUS =  1,191E-03 M        CORONA WIRE LENGTH =  1,906E+00 M
CURRENT/M =  6.100E-06 AMP/M           CURRENT DENSITY =  2,001E-05 AMP/M2      DEPOSIT E FIELD =  2,001E+02 VOLT/M
1/2 WIRE TO WIRE =  6,350E-02 M        GAS FLOW RATE =  9,460E-02 M3/SEC        GAS VELOCITY =  9,760E-01 M/SEC
TEMPERATURE = 297,667 K                PRESSURE =   1,000 ATM                   VISCOSITY =  1,800E-05 KG/M-SEC
ION MOBILITY =  1,798E-04 M2/VOLT-SEC  MEAN THERMAL SPEED =  4,439E+02 M/SEC    PART. PATH PARAM. =  5,708E-08 M
DUST WEIGHT =  3.250E-06 KG/SEC        LENGTH INCR. = ,25416565 M               INPUT EFF./INCR. = 31,67

ROVRI     ERAVG       EPLT        AFID       CMCD      MMD        WEIGHT     DUST LAYER   J(PART)      J(ION)   INCR. NO.

1,2497   2,913E+05  1.7869E+05  1,9100E+12    2,0   6,97E-06   4,210E-06   1,233E-04   1,68E-08    2,00E-05       4
1,1586   2,913E+05  1.7788E+05  2,0602E+12    2,0   4,15E-06   3,026E-06   8,866E-05   1,86E-08    2,00E-05       5
1,1002   2,913E+05  1.7789E+05  2,1695E+12    2,0   3,21E-06   2,339E-06   6,851E-05   1,87E-08    2,00E-05       6

CALCULATION IS IN SECTION NO. = 3 AND THE SECTION LENGTH IS =  1,5250 M

COLLECTION AREA =  1,163E+00 M2        APPLIED VOLTAGE =  3.490E+04 VOLTS       TOTAL CURRENT =  2,326E-05 AMPS
WIRE TO PLATE =  1,270E-01 M           CORONA WIRE RADIUS =  1,191E-03 M        CORONA WIRE LENGTH =  3,813E+00 M
CURRENT/M =  6.100E-06 AMP/M           CURRENT DENSITY =  2,001E-05 AMP/M2      DEPOSIT E FIELD =  2,001E+02 VOLT/M
1/2 WIRE TO WIRE =  6.350E-02 M        GAS FLOW RATE =  9,460E-02 M3/SEC        GAS VELOCITY =  9,760E-01 M/SEC
TEMPERATURE = 297,667 K                PRESSURE =   1,000 ATM                   VISCOSITY =  1,800E-05 KG/M-SEC
ION MOBILITY =  1,798E-04 M2/VOLT-SEC  MEAN THERMAL SPEED =  4,439E+02 M/SEC    PART. PATH PARAM. =  5,708E-08 M
DUST WEIGHT =  3.250E-06 KG/SEC        LENGTH INCR. = ,25416565 M               INPUT EFF./INCR. = 31,67

ROVRI     ERAVG       EPLT        AFID       CMCD      MMD        WEIGHT     DUST LAYER   J(PART)      J(ION)   INCR. NO.

1,0596   2,748E+05  1,6759E+05  2,3881E+12    2,0   2,77E-06   1,789E-06   5,242E-05   1,66E-08    2,00E-05       7
1,0378   2,748E+05  1,6759E+05  2,4383E+12    2,0   2,50E-06   1,517E-06   4.443E-05   1,60E-08    2,00E-05       8
1,0240   2,748E+05  1,6759E+05  2,4712E+12    2,0   2,33E-06   1,310E-06   3,839E-05   1,54E-08    2,00E-05       9
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1.0152  2.748E+05  1.6759E+05  2.4926E+12   2.0  2.19E-06  1.145E-06  3.354E-05  1.44E-08  2.00E-05   10
1.0097  2.748E+05  1.6759E+05  2.5063E+12   2.0  2.07E-06  1.008E-06  2.953E-05  1.37E-08  2.00E-05   11
1.0061  2.748E+05  1.6759E+05  2.5151E+12   2.0  1.95E-06  8.918E-07  2.613E-05  1.29E-08  2.00E-05   12
EST. EFFICIENCY = 99.00     UNCORRECTED COMPUTED EFFICIENCY = 74.47

INCREMENTAL ANALYSIS OF PRECIPITATOR PERFORMANCE


LAB ESP: SCA=125FT2/1000ACFM;J=2 NA/CM2

CALCULATION IS IN SECTION NO. = 1 AND THE SECTION LENGTH IS =  0.7625 M

COLLECTION AREA =  5.813E-01 M2        APPLIED VOLTAGE =  3.750E+04 VOLTS        TOTAL CURRENT =  1.163E-05 AMPS
WIRE TO PLATE =  1.270E-01 M           CORONA WIRE RADIUS =  1.191E-03 M         CORONA WIRE LENGTH =  1.906E+00 M
CURRENT/M =  6.100E-06 AMP/M           CURRENT DENSITY =  2.001E-05 AMP/M2       DEPOSIT E FIELD =  2.001E+02 VOLT/M
1/2 WIRE TO WIRE =  6.350E-02 M        GAS FLOW RATE =  9.460E-02 M3/SEC         GAS VELOCITY =  9.760E-01 M/SEC
TEMPERATURE = 297.667 K                PRESSURE =   1.000 ATM                    VISCOSITY =  1.800E-05 KG/M-SEC
ION MOBILITY =  1.798E-04 M2/VOLT-SEC  MEAN THERMAL SPEED =  4.439E+02 M/SEC      PART. PATH PARAM. =  5.708E-08 M
DUST WEIGHT =  3.250E-06 KG/SEC        LENGTH INCR. = .25416565 M                INPUT EFF./INCR. = 10.75

ROVRI     EHAVG       EPLT        AFID       CMCD    MMD       WEIGHT     DUST LAYER  J(PART)    J(ION)    INCR. NO.

1.3051  2.953E+05  1.8150E+05  1.8045E+12   2.0  7.74E-06  2.437E-06  7.141E-05  3.21E-09  2.00E-05    1
1.2637  2.953E+05  1.8106E+05  1.8637E+12   2.0  7.30E-06  3.526E-06  1.033E-04  7.99E-09  2.00E-05    2
1.2237  2.953E+05  1.8048E+05  1.9246E+12   2.0  7.16E-06  4.216E-06  1.235E-04  1.40E-08  2.00E-05    3
CALCULATION IS IN SECTION NO. = 2 AND THE SECTION LENGTH IS =  0.7625 M

COLLECTION AREA =  5.813E-01 M2        APPLIED VOLTAGE =  3.700E+04 VOLTS        TOTAL CURRENT =  1.163E-05 AMPS
WIRE TO PLATE =  1.270E-01 M           CORONA WIRE RADIUS =  1.191E-03 M         CORONA WIRE LENGTH =  1.906E+00 M
CURRENT/M =  6.100E-06 AMP/M           CURRENT DENSITY =  2.001E-05 AMP/M2       DEPOSIT E FIELD =  2.001E+02 VOLT/M
1/2 WIRE TO WIRE =  6.350E-02 M        GAS FLOW RATE =  9.460E-02 M3/SEC         GAS VELOCITY =  9.760E-01 M/SEC
TEMPERATURE = 297.667 K                PRESSURE =   1.000 ATM                    VISCOSITY =  1.800E-05 KG/M-SEC
ION MOBILITY =  1.798E-04 M2/VOLT-SEC  MEAN THERMAL SPEED =  4.439E+02 M/SEC      PART. PATH PARAM. =  5.708E-08 M
DUST WEIGHT =  3.250E-06 KG/SEC        LENGTH INCR. = .25416565 M                INPUT EFF./INCR. = 10.75

ROVRI     EHAVG       EPLT        AFID       CMCD    MMD       WEIGHT     DUST LAYER  J(PART)    J(ION)    INCR. NO.

1.1844  2.913E+05  1.7801E+05  2.0153E+12   2.0  4.79E-06  3.483E-06  1.020E-04  1.78E-08  2.00E-05    4
1.1528  2.913E+05  1.7789E+05  2.0706E+12   2.0  3.71E-06  2.775E-06  8.129E-05  1.91E-08  2.00E-05    5
1.1262  2.913E+05  1.7788E+05  2.1195E+12   2.0  3.11E-06  2.232E-06  6.539E-05  1.87E-08  2.00E-05    6
CALCULATION IS IN SECTION NO. = 3 AND THE SECTION LENGTH IS =  1.5250 M

COLLECTION AREA =  1.163E+00 M2        APPLIED VOLTAGE =  3.490E+04 VOLTS        TOTAL CURRENT =  2.326E-05 AMPS
WIRE TO PLATE =  1.270E-01 M           CORONA WIRE RADIUS =  1.191E-03 M         CORONA WIRE LENGTH =  3.813E+00 M
CURRENT/M =  6.100E-06 AMP/M           CURRENT DENSITY =  2.001E-05 AMP/M2       DEPOSIT E FIELD =  2.001E+02 VOLT/M
1/2 WIRE TO WIRE =  6.350E-02 M        GAS FLOW RATE =  9.460E-02 M3/SEC         GAS VELOCITY =  9.760E-01 M/SEC
TEMPERATURE = 297.667 K                PRESSURE =   1.000 ATM                    VISCOSITY =  1.800E-05 KG/M-SEC
ION MOBILITY =  1.798E-04 M2/VOLT-SEC  MEAN THERMAL SPEED =  4.439E+02 M/SEC      PART. PATH PARAM. =  5.708E-08 M
DUST WEIGHT =  3.250E-06 KG/SEC        LENGTH INCR. = .25416565 M                INPUT EFF./INCR. = 10.75

ROVRI     EHAVG       EPLT        AFID       CMCD    MMD       WEIGHT     DUST LAYER  J(PART)    J(ION)    INCR. NO.
```

```
1.0983   2.748E+05  1.6784E+05  2.3041E+12     2.0   2.73E-06    1.727E-06   5.058E-05   1.67E-08    2.00E-05      7
1.0816   2.748E+05  1.6760E+05  2.3397E+12     2.0   2.47E-06    1.458E-06   4.272E-05   1.58E-08    2.00E-05      8
1.0677   2.748E+05  1.6759E+05  2.3699E+12     2.0   2.30E-06    1.252E-06   3.669E-05   1.49E-08    2.00E-05      9
1.0563   2.748E+05  1.6758E+05  2.3956E+12     2.0   2.15E-06    1.088E-06   3.188E-05   1.41E-08    2.00E-05     10
1.0468   2.748E+05  1.6758E+05  2.4173E+12     2.0   2.02E-06    9.545E-07   2.796E-05   1.33E-08    2.00E-05     11
1.0389   2.748E+05  1.6758E+05  2.4356E+12     2.0   1.91E-06    8.434E-07   2.471E-05   1.25E-08    2.00E-05     12

EST. EFFICIENCY = 74.47     UNCORRECTED COMPUTED EFFICIENCY = 75.67


INCREMENTAL ANALYSIS OF PRECIPITATOR PERFORMANCE


LAB ESP: SCA=125F12/1000ACFM:J=2 NA/CM2


CALCULATION IS IN SECTION NO. = 1 AND THE SECTION LENGTH IS =  0.7625 M

COLLECTION AREA =  5.813E-01 M2             APPLIED VOLTAGE =  3.750E+04 VOLTS          TOTAL CURRENT =  1.163E-05 AMPS
WIRE TO PLATE =  1.270E-01 M                CORONA WIRE RADIUS =  1.191E-03 M           CORONA WIRE LENGTH =  1.906E+00 M
CURRENT/M =  6.100E-06 AMP/M                CURRENT DENSITY =  2.001E-05 AMP/M2         DEPOSIT E FIELD =  2.001E+02 VOLT/M
1/2 WIRE TO WIRE =  6.350E-02 M             GAS FLOW RATE =  9.460E-02 M3/SEC           GAS VELOCITY =  9.760E-01 M/SEC
TEMPERATURE = 297.667 K                     PRESSURE =   1.000 ATM                      VISCOSITY =  1.800E-05 KG/M-SEC
ION MOBILITY =  1.798E-04 M2/VOLT-SEC       MEAN THERMAL SPEED =  4.439E+02 M/SEC       PART. PATH PARAM. =  5.708E-08 M
DUST WEIGHT =  3.250E-06 KG/SEC             LENGTH INCR. = .25416565 M                  INPUT EFF./INCH. = 11.11


ROVRI     ERAVG        EPLT         AFID        CMCD      MMD          WEIGHT     DUST LAYER   J(PART)      J(ION)    INCR. NO.

1.3152   2.953E+05  1.8151E+05  1.7906E+12     2.0   7.74E-06    2.423E-06   7.100E-05   3.16E-09    2.00E-05      1
1.2714   2.953E+05  1.8106E+05  1.8524E+12     2.0   7.30E-06    3.511E-06   1.028E-04   7.92E-09    2.00E-05      2
1.2294   2.953E+05  1.8051E+05  1.9157E+12     2.0   7.55E-06    4.367E-06   1.285E-04   1.45E-08    2.00E-05      3

CALCULATION IS IN SECTION NO. = 2 AND THE SECTION LENGTH IS =  0.7625 M

COLLECTION AREA =  5.813E-01 M2             APPLIED VOLTAGE =  3.700E+04 VOLTS          TOTAL CURRENT =  1.163E-05 AMPS
WIRE TO PLATE =  1.270E-01 M                CORONA WIRE RADIUS =  1.191E-03 M           CORONA WIRE LENGTH =  1.906E+00 M
CURRENT/M =  6.100E-06 AMP/M                CURRENT DENSITY =  2.001E-05 AMP/M2         DEPOSIT E FIELD =  2.001E+02 VOLT/M
1/2 WIRE TO WIRE =  6.350E-02 M             GAS FLOW RATE =  9.460E-02 M3/SEC           GAS VELOCITY =  9.760E-01 M/SEC
TEMPERATURE = 297.667 K                     PRESSURE =   1.000 ATM                      VISCOSITY =  1.800E-05 KG/M-SEC
ION MOBILITY =  1.798E-04 M2/VOLT-SEC       MEAN THERMAL SPEED =  4.439E+02 M/SEC       PART. PATH PARAM. =  5.708E-08 M
DUST WEIGHT =  3.250E-06 KG/SEC             LENGTH INCR. = .25416565 M                  INPUT EFF./INCH. = 11.11


ROVRI     ERAVG        EPLT         AFID        CMCD      MMD          WEIGHT     DUST LAYER   J(PART)      J(ION)    INCR. NO.

1.1802   2.913E+05  1.7804E+05  2.0088E+12     2.0   4.79E-06    3.472E-06   1.017E-04   1.79E-08    2.00E-05      4
1.1553   2.913E+05  1.7789E+05  2.0660E+12     2.0   3.64E-06    2.732E-06   6.003E-05   1.91E-08    2.00E-05      5
1.1278   2.913E+05  1.7788E+05  2.1164E+12     2.0   3.06E-06    2.194E-06   6.428E-05   1.87E-08    2.00E-05      6

CALCULATION IS IN SECTION NO. = 3 AND THE SECTION LENGTH IS =  1.5250 M

COLLECTION AREA =  1.163E+00 M2             APPLIED VOLTAGE =  3.490E+04 VOLTS          TOTAL CURRENT =  2.326E-05 AMPS
WIRE TO PLATE =  1.270E-01 M                CORONA WIRE RADIUS =  1.191E-03 M           CORONA WIRE LENGTH =  3.813E+00 M
CURRENT/M =  6.100E-06 AMP/M                CURRENT DENSITY =  2.001E-05 AMP/M2         DEPOSIT E FIELD =  2.001E+02 VOLT/M
1/2 WIRE TO WIRE =  6.350E-02 M             GAS FLOW RATE =  9.460E-02 M3/SEC           GAS VELOCITY =  9.760E-01 M/SEC
TEMPERATURE = 297.667 K                     PRESSURE =   1.000 ATM                      VISCOSITY =  1.800E-05 KG/M-SEC
ION MOBILITY =  1.798E-04 M2/VOLT-SEC       MEAN THERMAL SPEED =  4.439E+02 M/SEC       PART. PATH PARAM. =  5.708E-08 M
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DUST WEIGHT =  3.250E-06 KG/SEC       LENGTH INCH. = .25410565 M           INPUT EFF./INCH. = 11.11

ROVRI     ERAVG        EPLT         AFID       CKCD      SMD        WEIGHT     DUST LAYER   J(PART)       J(ION)     INCH. NO.

1.0992   2.748E+05   1.6765E+05   2.3022E+12    2.0    2.68E-06   1.702E-06   4.985E-05   1.67E-08     2.00E-05        7
1.0820   2.748E+05   1.6761E+05   2.3367E+12    2.0    2.45E-06   1.443E-06   4.226E-05   1.58E-08     2.00E-05        8
1.0678   2.748E+05   1.6760E+05   2.3697E+12    2.0    2.28E-06   1.243E-06   3.642E-05   1.49E-08     2.00E-05        9
1.0562   2.748E+05   1.6759E+05   2.3959E+12    2.0    2.14E-06   1.063E-06   3.173E-05   1.41E-08     2.00E-05       10
1.0465   2.748E+05   1.6759E+05   2.4180E+12    2.0    2.02E-06   9.521E-07   2.789E-05   1.33E-08     2.00E-05       11
1.0385   2.748E+05   1.6759E+05   2.4366E+12    2.0    1.90E-06   8.425E-07   2.468E-05   1.25E-08     2.00E-05       12

EST EFFICIENCY = 75.67       COMPUTED EFFICIENCY = 75.64      CONVERGES
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CHARGING RATES FOR PARTICLE SIZES FROM SUBROUTINE CHARGN OR CHGSUP

SRI THEORY USED FOR PARTICLE CHARGING

INCREMENT NO.     Q/QSATF FOR INDICATED PARTICLE SIZES

  0.2500E-06   0.3500E-06   0.4500E-06   0.5500E-06   0.7000E-06   0.9000E-06   0.1100E-05   0.1300E-05
 1  0.5201       0.5076       0.4894       0.4719       0.4500       0.4280       0.4122       0.4005
 2  0.8010       0.7849       0.7601       0.7366       0.7074       0.6786       0.6579       0.6426
 3  1.0306       1.0201       0.9930       0.9651       0.9290       0.8925       0.8660       0.8466
 4  1.2294       1.2265       1.2047       1.1795       1.1440       1.1041       1.0722       1.0475
 5  1.3715       1.3668       1.3430       1.3165       1.2804       1.2417       1.2128       1.1915
 6  1.4812       1.4714       1.4426       1.4119       1.3707       1.3271       1.2946       1.2705
 7  1.5669       1.5490       1.5131       1.4765       1.4283       1.3776       1.3397       1.3114
 8  1.6388       1.6135       1.5711       1.5292       1.4748       1.4181       1.3757       1.3439
 9  1.7007       1.6684       1.6203       1.5737       1.5138       1.4519       1.4056       1.3708
10  1.7548       1.7162       1.6628       1.6120       1.5473       1.4807       1.4311       1.3936
11  1.8029       1.7585       1.7003       1.6457       1.5766       1.5059       1.4533       1.4137
12  1.8461       1.7963       1.7337       1.6756       1.6026       1.5281       1.4729       1.4313

  0.1600E-05   0.2000E-05   0.2600E-05   0.3500E-05   0.5000E-05   0.8000E-05   0.1500E-04
 1  0.3880       0.3769       0.3665       0.3575       0.3499       0.3446       0.3453
 2  0.6261       0.6116       0.5987       0.5892       0.5847       0.5895       0.6213
 3  0.8262       0.8096       0.7976       0.7944       0.8062       0.8642       1.3897
 4  1.0236       1.0081       1.0060       1.0315       1.1121       1.1897       1.3897
 5  1.1708       1.1579       1.1573       1.1738       1.2013       1.2239       1.3897
 6  1.2461       1.2287       1.2208       1.2252       1.2357       1.2413       1.3897
 7  1.2818       1.2588       1.2440       1.2403       1.2429       1.2432       1.3897
 8  1.3102       1.2828       1.2627       1.2529       1.2493       1.2432       1.3897
 9  1.3337       1.3026       1.2783       1.2637       1.2550       1.2432       1.3897
10  1.3536       1.3196       1.2918       1.2732       1.2550       1.2432       1.3897
11  1.3710       1.3343       1.3035       1.2815       1.2550       1.2432       1.3897
12  1.3863       1.3473       1.3139       1.2890       1.2550       1.2432       1.3897
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  CHARGE ACCUMULATED ON PARTICLE SIZES IN EACH INCREMENT

INCREMENT        CHARGE FOR INDICATED PARTICLE SIZES

       0.2500E-06   0.3500E-06   0.4500E-06   0.5500E-06   0.7000E-06   0.9000E-06   0.1100E-05   0.1300E-05
  1   0.74563E-18  0.12867E-17  0.19442E-17  0.27128E-17  0.40702E-17  0.62604E-17  0.88863E-17  0.11958E-16
  2   0.11484E-17  0.19898E-17  0.30199E-17  0.42341E-17  0.63967E-17  0.99258E-17  0.14187E-16  0.19187E-16
  3   0.14775E-17  0.25801E-17  0.39451E-17  0.55475E-17  0.84034E-17  0.13055E-16  0.18676E-16  0.25276E-16
  4   0.17624E-17  0.31093E-17  0.47861E-17  0.67798E-17  0.10348E-16  0.16150E-16  0.23122E-16  0.31278E-16
  5   0.19662E-17  0.34649E-17  0.53354E-17  0.75674E-17  0.11562E-16  0.18163E-16  0.26153E-16  0.35576E-16
  6   0.21234E-17  0.37300E-17  0.57312E-17  0.81157E-17  0.12399E-16  0.19412E-16  0.27917E-16  0.37934E-16
  7   0.22463E-17  0.39268E-17  0.60113E-17  0.84871E-17  0.12919E-16  0.20151E-16  0.28890E-16  0.39155E-16
  8   0.23494E-17  0.40901E-17  0.62417E-17  0.87904E-17  0.13341E-16  0.20743E-16  0.29668E-16  0.40126E-16
  9   0.24380E-17  0.42295E-17  0.64370E-17  0.90459E-17  0.13693E-16  0.21237E-16  0.30312E-16  0.40931E-16
 10   0.25157E-17  0.43507E-17  0.66061E-17  0.92663E-17  0.13996E-16  0.21659E-16  0.30862E-16  0.41615E-16
 11   0.25846E-17  0.44578E-17  0.67548E-17  0.94597E-17  0.14261E-16  0.22027E-16  0.31340E-16  0.42210E-16
 12   0.26465E-17  0.45536E-17  0.68875E-17  0.96316E-17  0.14496E-16  0.22352E-16  0.31763E-16  0.42735E-16

       0.1600E-05   0.2000E-05   0.2600E-05   0.3500E-05   0.5000E-05   0.8000E-05   0.1500E-04
  1   0.17399E-16  0.26222E-16  0.42823E-16  0.75299E-16  0.14975E-15  0.37644E-15  0.13215E-14
  2   0.28076E-16  0.42547E-16  0.69943E-16  0.12410E-15  0.25020E-15  0.64357E-15  0.23780E-14
  3   0.37047E-16  0.56319E-16  0.93182E-16  0.16731E-15  0.34503E-15  0.94340E-15  0.53187E-14
  4   0.45898E-16  0.70128E-16  0.11753E-15  0.21724E-15  0.47596E-15  0.12987E-14  0.53187E-14
  5   0.52498E-16  0.80550E-16  0.13521E-15  0.24722E-15  0.51413E-15  0.13361E-14  0.53167E-14
  6   0.55878E-16  0.85475E-16  0.14262E-15  0.25805E-15  0.52884E-15  0.13551E-14  0.53187E-14
  7   0.57480E-16  0.87569E-16  0.14533E-15  0.26123E-15  0.53193E-15  0.13571E-14  0.53187E-14
  8   0.58752E-16  0.89237E-16  0.14752E-15  0.26388E-15  0.53466E-15  0.13571E-14  0.53187E-14
  9   0.59804E-16  0.90620E-16  0.14935E-15  0.26616E-15  0.53712E-15  0.13571E-14  0.53187E-14
 10   0.60699E-16  0.91799E-16  0.15091E-15  0.26814E-15  0.53712E-15  0.13571E-14  0.53187E-14
 11   0.61477E-16  0.92824E-16  0.15229E-15  0.26990E-15  0.53712E-15  0.13571E-14  0.53187E-14
 12   0.62163E-16  0.93730E-16  0.15350E-15  0.27148E-15  0.53712E-15  0.13571E-14  0.53187E-14
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PARTICLE SIZE RANGE STATISTICS

CORRECTIONS FOR NONIDEALITIES USING SET NO.  1 OF CORRECTION PARAMETERS

   SIZE      CCF  INLET % OUTLET % COR. OUTLET % NO-RAP EFF. NO-RAP W  NO-RAP P  COR. EFF.   COR. W     COR. P
 2.500E-07  1.590  0.000   0.0006       0.0005     52.1556     3.000   47.8444    52.1556    3.000     47.8444
 3.500E-07  1.414  0.400   1.0876       0.9391     53.2724     3.096   46.7276    52.4931    3.028     47.5069
 4.500E-07  1.320  0.600   1.5755       1.3650     54.8737     3.238   45.1263    53.9671    3.157     46.0329
 5.500E-07  1.261  1.667   4.1916       3.5999     56.7867     3.414   43.2133    56.3035    3.369     43.6965
 7.000E-07  1.205  5.000  11.8389      10.1752     59.3073     3.658   40.6927    58.8222    3.610     41.1778
 9.000E-07  1.159  4.933  10.7383       9.2913     62.5890     4.000   37.4110    61.8889    3.925     38.1111
 1.100E-06  1.130  4.733   9.5239       8.3037     65.4180     4.320   34.5820    64.5005    4.214     35.4995
 1.300E-06  1.110  4.000   7.4467       6.5752     68.0053     4.637   31.9947    66.7388    4.479     33.2612
 1.600E-06  1.090  8.000  13.3950      11.9544     71.2242     5.068   28.7758    69.7637    4.867     30.2363
 2.000E-06  1.072  6.667   9.7231       8.8964     74.9362     5.630   25.0638    72.9996    5.327     27.0004
 2.600E-06  1.055 10.667  12.7300      12.1372     79.4902     6.446   20.5098    76.9768    5.976     23.0232
 3.500E-06  1.041 10.667   9.7155       9.8250     84.3470     7.540   15.6530    81.3629    6.836     18.6371
 5.000E-06  1.029 11.333   6.3237       7.9473     90.4104     9.539    9.5896    85.8106    7.945     14.1894
 8.000E-06  1.018 12.000   1.6710       4.6054     97.6069    15.187    2.3931    92.2344   10.398      7.7656
 1.500E-05  1.010 19.333   0.0386       4.3844     99.9657    32.461    0.0343    95.4111   12.538      4.5889

EFFICIENCIES FOR CONVERGENCE CHECK:  STATED OR PREVIOUS CALCULATION =  75.670   FINAL CALCULATION =  75.644


    ADJUSTED NO-RAP EFF. =  82.8141
    MMD OF INLET SIZE DISTRIBUTION =  3.302E+00
    SIGMAP OF INLET SIZE DISTRIBUTION =  2.164E+00
    LOG-NORMAL GOODNESS OF FIT =  0.935
    MMD OF EFFLUENT UNDER NO-RAP CONDITIONS =  1.623E+00
    SIGMAP OF EFFLUENT UNDER NO-RAP CONDITIONS =  1.729E+00
    LOG-NORMAL GOODNESS OF FIT =  0.964
    PRECIPITATION RATE PARAMETER UNDER NO-RAP CONDITIONS =  7.166


    SIGMAG=    0.000  WITH  0.000 SNEAKAGE OVER    4.000  STAGES
    NTEMP = 1
    RMMD =  6.00
    RSIGMA = 2.50
    CORR. EFF. =  79.7657
    CORRECTED MMD OF EFFLUENT =  2.055E+00
    CORRECTED SIGMAP OF EFFLUENT =  1.955E+00
    LOG-NORMAL GOODNESS OF FIT =  0.946
    CORRECTED PRECIPITATION RATE PARAMETER =     6.50
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UNADJUSTED MIGRATION VELOCITIES AND EFFICIENCIES, AND DISCRETE OUTLET MASS LOADINGS

IDEAL UNADJUSTED MIG. VEL. (CM/SEC)	IDEAL UNADJUSTED EFFICIENCY (%)	NO-RAP DM/DLOGD (MG/DSCM)	RAPPING PUFF DM/DLOGD (MG/DSCM)	NO-RAP+RAP PUFF DM/DLOGD (MG/DSCM)	RAPPING PUFF DISTRIBUTION (%)	PARTICLE DIAM. (M)
1.290E+00	2.717E+01	2.039E-04	2.834E-03	3.037E-03	4.360E-02	2.500E-07
1.427E+00	2.957E+01	5.614E-01	9.363E-03	5.707E-01	1.022E-01	3.500E-07
1.579E+00	3.217E+01	1.048E+00	2.106E-02	1.069E+00	1.784E-01	4.500E-07
1.737E+00	3.475E+01	3.414E+00	3.818E-02	3.452E+00	2.642E-01	5.500E-07
1.977E+00	3.849E+01	6.111E+00	7.285E-02	6.184E+00	7.953E-01	7.000E-07
2.299E+00	4.317E+01	7.146E+00	1.337E-01	7.280E+00	1.132E+00	9.000E-07
2.622E+00	4.750E+01	7.757E+00	2.058E-01	7.963E+00	1.424E+00	1.100E-06
2.946E+00	5.152E+01	7.174E+00	2.840E-01	7.458E+00	1.861E+00	1.300E-06
3.438E+00	5.705E+01	7.915E+00	4.017E-01	8.317E+00	3.831E+00	1.600E-06
4.110E+00	6.358E+01	7.195E+00	5.559E-01	7.751E+00	4.234E+00	2.000E-06
5.149E+00	7.179E+01	6.095E+00	7.469E-01	6.842E+00	6.791E+00	2.600E-06
6.767E+00	8.105E+01	5.015E+00	9.560E-01	5.971E+00	1.044E+01	3.500E-06
9.539E+00	9.041E+01	2.316E+00	1.111E+00	3.427E+00	1.709E+01	5.000E-06
1.519E+01	9.761E+01	4.857E-01	1.090E+00	1.576E+00	2.114E+01	8.000E-06
3.246E+01	9.997E+01	8.265E-03	1.098E+00	1.106E+00	2.887E+01	1.500E-05

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                              E.P.A. ESP MODEL
                        I.E.R.L.-R.T.P. AND SO.R.I.

                       SUMMARY TABLE OF ESP OPERATING
                         PARAMETERS AND PERFORMANCE


                            DATA SET NUMBER   1

                      NON-IDEAL CONDITION SET NUMBER  1

ESP PERFORMANCE:     EFFICIENCY =  79.7657 %     SCA =  2.458E+01 M**2/(M**3/SEC)
                                                      ( 125. FT**2/1000 ACFM)

ELECTRICAL CONDITIONS:     AVG. APPLIED VOLTAGE =  3.607E+04 V
                           AVG. CURRENT DENSITY =    2.00 NA/CM**2
                           RESISTIVITY =  1.000E+09 OHM-CM

SIZE DISTRIBUTIONS:     INLET MMD =  3.302E+00 UM     INLET SIGMAP =  2.164E+00
                        OUTLET MMD =  2.055E+00 UM    OUTLET SIGMAP =  1.955E+00

NONIDEAL PARAMETERS:     GAS SNEAKAGE FRACTION =  .00 /SECTION     GAS VELOCITY SIGMAG =  .00
                         RAPPING MMD =  6.000E+00 UM     RAPPING SIGMAP =  2.500E+00

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                    *                                   *
                    *        E.P.A. ESP MODEL           *
                    *   I.E.R.L.-R.T.P. AND SO.R.I.     *
                    *         REVISION III              *
                    *                                   *
                    *************************************

PRINTOUT OF INPUT DATA FOR DATA SET NUMBER  2


>>>>> CHECK VALUE OF TCS( 1)
>>>>> CHECK VALUE OF TCS( 2)
>>>>> CHECK VALUE OF TCS( 3)

 DATA ON CARD NUMBER   1

 NENDPT = 16   NDATA =  4   NRAP =  0   MODL =  0   NOPRNT =  0   PATHL =  0.00 FT   NCOMPS =  0   NWAVES =  0  NLAMDA =  0

 DATA ON CARD NUMBER   2

 LAB ESP: SCA=125FT2/1000ACFM;J=5 NA/CM2

 DATA ON CARD NUMBER   3

 VOS( 1) =  3.9450E+04 V  TCS( 1) =  2.9070E-05 A
 VOS( 2) =  3.9000E+04 V  TCS( 2) =  2.9070E-05 A
 VOS( 3) =  3.7200E+04 V  TCS( 3) =  5.8140E-05 A
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PARTICLE SIZE RANGE STATISTICS

CORRECTIONS FOR NONIDEALITIES USING SET NO.  1 OF CORRECTION PARAMETERS

   SIZE      CCF  INLET % OUTLET % COR. OUTLET % NO-RAP EFF. NO-RAP W  NO-RAP P  COR. EFF.   COR. W     COR. P
2.500E-07  1.590  0.000   0.0007        0.0005     67.1475     4.529   32.8525   67.1475    4.529     32.8525
3.500E-07  1.414  0.400   1.3116        1.0478     67.8967     4.623   32.1033   67.1983    4.535     32.8017
4.500E-07  1.320  0.600   1.8846        1.5124     69.2465     4.796   30.7535   68.4341    4.692     31.5659
5.500E-07  1.261  1.667   4.9453        3.9242     70.9549     5.030   29.0451   70.5218    4.970     29.4782
7.000E-07  1.205  5.000  13.6869       10.8748     73.1990     5.358   26.8010   72.7643    5.292     27.2357
9.000E-07  1.159  4.933  12.0423        9.6625     76.0991     5.824   23.9009   75.4717    5.718     24.5283
1.100E-06  1.130  4.733  10.3697        8.4184     78.5490     6.264   21.4510   77.7269    6.111     22.2731
1.300E-06  1.110  4.000   7.8691        6.5150     80.7389     6.702   19.2611   79.6040    6.469     20.3960
1.600E-06  1.090  8.000  13.5933       11.4641     83.3639     7.296   16.6361   82.0552    6.990     17.9448
2.000E-06  1.072  6.667   9.3715        8.2512     86.2375     8.069   13.7625   84.5021    7.586     15.4979
2.600E-06  1.055 10.667  11.4372       10.8609     89.5023     9.171   10.4977   87.2500    8.380     12.7500
3.500E-06  1.041 10.667   8.1348        8.6381     92.5335    10.558    7.4665   89.8594    9.312     10.1406
5.000E-06  1.029 11.333   4.5633        7.2962     96.0577    13.156    3.9423   91.9358   10.244      8.0642
8.000E-06  1.018 12.000   0.7896        5.2308     99.3558    20.527    0.6442   94.5414   11.832      5.4586
1.500E-05  1.010 19.333   0.0002        6.3010     99.9999   236.016    0.0001   95.9186   13.015      4.0814

EFFICIENCIES FOR CONVERGENCE CHECK:  STATED OR PREVIOUS CALCULATION =  83.386   FINAL CALCULATION =  83.387

   ADJUSTED NO-RAP EFF. =  90.2092
   MMD OF INLET SIZE DISTRIBUTION =  3.302E+00
   SIGMAP OF INLET SIZE DISTRIBUTION =  2.164E+00
   LOG-NORMAL GOODNESS OF FIT =  0.935
   MMD OF EFFLUENT UNDER NO-RAP CONDITIONS =  1.465E+00
   SIGMAP OF EFFLUENT UNDER NO-RAP CONDITIONS =  1.670E+00
   LOG-NORMAL GOODNESS OF FIT =  0.959
   PRECIPITATION RATE PARAMETER UNDER NO-RAP CONDITIONS =  9.455

   SIGMAG=     0.000  WITH  0.000 SNEAKAGE OVER    4.000  STAGES
   NTEMP = 1
   RMMD =  6.00
   RSIGMA = 2.50
   CORR. EFF. =  87.4776
   CORRECTED MMD OF EFFLUENT =  2.090E+00
   CORRECTED SIGMAP OF EFFLUENT =  2.012E+00
   LOG-NORMAL GOODNESS OF FIT =  0.935
   CORRECTED PRECIPITATION RATE PARAMETER =     8.45
```

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*****************************************************************************************
*                                                                                       *
*                               E.P.A. ESP MODEL                                        *
*                          I.E.R.L.-R.T.P. AND SO.R.I.                                  *
*                                                                                       *
*                         SUMMARY TABLE OF ESP OPERATING                                *
*                           PARAMETERS AND PERFORMANCE                                  *
*                                                                                       *
*                                                                                       *
*                               DATA SET NUMBER   2                                     *
*                                                                                       *
*                         NON-IDEAL CONDITION SET NUMBER  1                             *
*                                                                                       *
*    ESP PERFORMANCE:     EFFICIENCY =  87.4776 %     SCA =  2.458E+01 M**2/(M**3/SEC)  *
*                                                        ( 125. FT**2/1000 ACFM)       *
*                                                                                       *
*    ELECTRICAL CONDITIONS:     AVG. APPLIED VOLTAGE =  3.821E+04 V                     *
*                               AVG. CURRENT DENSITY =    5.00 NA/CM**2                 *
*                               RESISTIVITY =  1.000E+09 OHM-CM                         *
*                                                                                       *
*    SIZE DISTRIBUTIONS:     INLET MMD =  3.302E+00 UM     INLET SIGMAP =  2.164E+00    *
*                            OUTLET MMD =  2.090E+00 UM     OUTLET SIGMAP =  2.012E+00  *
*                                                                                       *
*    NONIDEAL PARAMETERS:     GAS SNEAKAGE FRACTION =  .00 /SECTION     GAS VELOCITY SIGMAG =  .00  *
*                             RAPPING MMD =  6.000E+00 UM     RAPPING SIGMAP =  2.500E+00  *
*                                                                                       *
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*                                 *
*         E.P.A. ESP MODEL        *
*    I.E.R.L.-R.T.P. AND SO.R.I.  *
*           REVISION III          *
*                                 *
***********************************

PRINTOUT OF INPUT DATA FOR DATA SET NUMBER  3

>>>>> CHECK VALUE OF TCS( 1)
>>>>> CHECK VALUE OF TCS( 2)

 DATA ON CARD NUMBER   1

 NENDPT = 16   NDATA =  4   NRAP =  0   MODL =  0   NOPRNT =  0   PATHL =  0.00 FT   NCOMPS =  0   NWAVES =  0  NLAMDA =  0

 DATA ON CARD NUMBER   2

 LAB ESP: SCA=125FT2/1000ACFM;J=10 NA/CM2

 DATA ON CARD NUMBER   3

 VOS( 1) =  4.1600E+04 V  TCS( 1) =  5.8140E-05 A
 VOS( 2) =  4.1200E+04 V  TCS( 2) =  5.8140E-05 A
 VOS( 3) =  3.9800E+04 V  TCS( 3) =  1.1628E-04 A
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PARTICLE SIZE RANGE STATISTICS


CORRECTIONS FOR NONIDEALITIES USING SET NO.  1 OF CORRECTION PARAMETERS

  SIZE       CCF  INLET % OUTLET % COR. OUTLET % NO-RAP EFF. NO-RAP W  NO-RAP P  COR. EFF.   COR. W     COR. P
2.500E-07  1.590  0.000   0.0008         0.0006     76.7926      5.943  23.2074   76.7926     5.943     23.2074
3.500E-07  1.414  0.400   1.5288         1.1219     77.2193      6.019  22.7807   76.6111     5.912     23.3889
4.500E-07  1.320  0.600   2.1832         1.6113     78.3125      6.219  21.6875   77.6050     6.088     22.3950
5.500E-07  1.261  1.667   5.6588         4.1199     79.7672      6.501  20.2328   79.3900     6.426     20.6100
7.000E-07  1.205  5.000  15.3771        11.2175     81.6695      6.903  18.3305   81.2910     6.820     18.7090
9.000E-07  1.159  4.933  13.1454         9.7187     84.1170      7.486  15.8830   83.5706     7.349     16.4294
1.100E-06  1.130  4.733  11.0118         8.2768     86.1328      8.039  13.8672   85.4168     7.834     14.5832
1.300E-06  1.110  4.000   8.1292         6.2843     87.8868      8.589  12.1132   86.8984     8.270     13.1016
1.600E-06  1.090  8.000  13.5410        10.7716     89.9114      9.333  10.0886   88.7717     8.697     11.2283
2.000E-06  1.072  6.667   8.9248         7.5871     92.0212     10.286   7.9788   90.5099     9.582      9.4901
2.600E-06  1.055 10.667  10.3309         9.8928     94.2275     11.605   5.7725   92.2660    10.414      7.7340
3.500E-06  1.041 10.667   6.8364         7.8650     96.1801     13.264   3.8199   93.8513    11.348      6.1487
5.000E-06  1.029 11.333   3.3018         7.2383     98.2635     16.492   1.7365   94.6738    11.932      5.3262
8.000E-06  1.018 12.000   0.0297         6.0544     99.9853     35.897   0.0147   95.7926    12.891      4.2074
1.500E-05  1.010 19.333   0.0003         8.2400     99.9999    679.469   0.0001   96.4457    13.578      3.5543

EFFICIENCIES FOR CONVERGENCE CHECK:  STATED OR PREVIOUS CALCULATION =  87.991   FINAL CALCULATION =  87.985


  ADJUSTED NO-RAP EFF. =  94.0397
  MMD OF INLET SIZE DISTRIBUTION =  3.302E+00
  SIGMAP OF INLET SIZE DISTRIBUTION =  2.164E+00
  LOG-NORMAL GOODNESS OF FIT =  0.935
  MMD OF EFFLUENT UNDER NO-RAP CONDITIONS =  1.372E+00
  SIGMAP OF EFFLUENT UNDER NO-RAP CONDITIONS =  1.644E+00
  LOG-NORMAL GOODNESS OF FIT =  0.961
  PRECIPITATION RATE PARAMETER UNDER NO-RAP CONDITIONS = 11.474


  SIGMAG=    0.000  WITH  0.000 SNEAKAGE OVER    4.000  STAGES
  NTEMP = 1
  RMMD =  6.00
  RSIGMA = 2.50
  CORR. EFF. =  91.6608
  CORRECTED MMD OF EFFLUENT =  2.153E+00
  CORRECTED SIGMAP OF EFFLUENT =  2.067E+00
  LOG-NORMAL GOODNESS OF FIT =  0.925
  CORRECTED PRECIPITATION RATE PARAMETER =   10.11
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*                                                                                                *
*                                     E.P.A. ESP MODEL                                           *
*                                I.E.R.L.-R.T.P. AND SO.R.I.                                     *
*                                                                                                *
*                               SUMMARY TABLE OF ESP OPERATING                                   *
*                                PARAMETERS AND PERFORMANCE                                      *
*                                                                                                *
*                                                                                                *
*                                    DATA SET NUMBER   3                                         *
*                                                                                                *
*                              NON-IDEAL CONDITION SET NUMBER  1                                 *
*                                                                                                *
*   ESP PERFORMANCE:     EFFICIENCY =  91.660 %     SCA =  2.458E+01 M**2/(M**3/SEC)             *
*                                                                                                *
*                                                   ( 125. FT**2/1000 ACFM)                      *
*                                                                                                *
*   ELECTRICAL CONDITIONS:     AVG. APPLIED VOLTAGE =  4.060E+04 V                               *
*                                                                                                *
*                              AVG. CURRENT DENSITY =   10.00 NA/CM**2                           *
*                                                                                                *
*                              RESISTIVITY =  1.000E+09 OHM-CM                                   *
*                                                                                                *
*   SIZE DISTRIBUTIONS:     INLET MMD =  3.302E+00 UM     INLET SIGMAP =  2.164E+00              *
*                                                                                                *
*                           OUTLET MMD =  2.153E+00 UM     OUTLET SIGMAP =  2.067E+00            *
*                                                                                                *
*   NONIDEAL PARAMETERS:     GAS SNEAKAGE FRACTION =  .00 /SECTION     GAS VELOCITY SIGMAG =  .00
*                                                                                                *
*                            RAPPING MMD =  6.000E+00 UM     RAPPING SIGMAP =  2.500E+00         *
*                                                                                                *
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                              ***********************************
                              *                                 *
                              *        E.P.A. ESP MODEL         *
                              *   I.E.R.L.-R.T.P. AND SO.R.I.   *
                              *          REVISION III           *
                              *                                 *
                              ***********************************

PRINTOUT OF INPUT DATA FOR DATA SET NUMBER  4


DATA ON CARD NUMBER   1

NENDPT = 16   NDATA =  4   NRAP =  0   NUDL =  0   NUPRNT =  0   PATHL =  0.00 FT   NCOMPS =  0   NWAVES =  0  NLAMDA =  0

DATA ON CARD NUMBER   2

LAB ESP: SCA=125FT2/1000ACFM;J=20 NA/CM2

DATA ON CARD NUMBER   3

VOS( 1) =  4.4700E+04 V  TCS( 1) =  1.1628E-04 A
VOS( 2) =  4.4400E+04 V  TCS( 2) =  1.1628E-04 A
VOS( 3) =  4.3000E+04 V  TCS( 3) =  2.3256E-04 A
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PARTICLE SIZE RANGE STATISTICS

CORRECTIONS FOR NONIDEALITIES USING SET NO.  1 OF CORRECTION PARAMETERS

  SIZE       CCF  INLET % OUTLET % COR. OUTLET % NO-RAP EFF. NO-RAP W  NO-RAP P  COR. EFF.   COR. W      COR. P
2.500E-07  1.590  0.000   0.0009       0.0006     85.5689      7.876   14.4311   85.5689    7.876      14.4311
3.500E-07  1.414  0.400   1.6209       1.1675     85.7483      7.927   14.2517   85.2574    7.789      14.7426
4.500E-07  1.320  0.600   2.5448       1.6700     86.5126      8.152   13.4874   85.9415    7.983      14.0585
5.500E-07  1.261  1.667   6.6075       4.1961     87.5905      8.490   12.4095   87.2861    8.392      12.7139
7.000E-07  1.205  5.000  17.5768      11.1974     88.9943      8.979   11.0057   88.6887    8.867      11.3113
9.000E-07  1.159  4.933  14.5154       9.4281     90.7877      9.703    9.2123   90.3467    9.512       9.6533
1.100E-06  1.130  4.733  11.7514       7.8256     92.2267     10.394    7.7733   91.6488   10.102       8.3512
1.300E-06  1.110  4.000   8.3771       5.8243     93.4434     11.086    6.5566   92.6456   10.619       7.3544
1.600E-06  1.090  8.000  13.3075       9.7057     94.7922     12.023    5.2078   93.8722   11.362       6.1278
2.000E-06  1.072  6.667   8.2646       6.7329     96.1190     13.220    3.8810   94.8992   12.106       5.1008
2.600E-06  1.055 10.667   6.6370       8.8212     97.4063     14.860    2.5937   95.8231   12.921       4.1769
3.500E-06  1.041 10.667   5.1689       7.1735     98.4829     17.042    1.5171   96.6033   13.762       3.3967
5.000E-06  1.029 11.333   1.1461       7.2362     99.6723     23.277    0.3277   96.7750   13.973       3.2250
8.000E-06  1.019 12.000   0.0004       8.0400     99.9999     72.133    0.0001   96.6159   13.777       3.3841
1.500E-05  1.010 19.333   0.0006      10.9809     99.9999    *******    0.0001   97.1312   14.449       2.8688

EFFICIENCIES FOR CONVERGENCE CHECK:  STATED OR PREVIOUS CALCULATION =  91.991   FINAL CALCULATION =  91.989

    ADJUSTED NO-RAP EFF. =  96.8692
    MMD OF INLET SIZE DISTRIBUTION =  3.302E+00
    SIGMAP OF INLET SIZE DISTRIBUTION =  2.164E+00
    LOG-NORMAL GOODNESS OF FIT =  0.935
    MMD OF EFFLUENT UNDER NO-RAP CONDITIONS =  1.256E+00
    SIGMAP OF EFFLUENT UNDER NO-RAP CONDITIONS =  1.599E+00
    LOG-NORMAL GOODNESS OF FIT =  0.967
    PRECIPITATION RATE PARAMETER UNDER NO-RAP CONDITIONS = 14.094


    SIGMAG=    0.000  WITH  0.000 SNEAKAGE OVER    4.000  STAGES
    NTEMP = 1
    RMMD =  6.00
    RSIGMA = 2.50
    CORR. EFF. =  94.9491
    CORRECTED MMD OF EFFLUENT =  2.289E+00
    CORRECTED SIGMAP OF EFFLUENT =  2.144E+00
    LOG-NORMAL GOODNESS OF FIT =  0.914
    CORRECTED PRECIPITATION RATE PARAMETER =   12.15
```

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                        E.P.A. ESP MODEL
                  I.E.R.L.-R.T.P. AND SO.R.I.

                 SUMMARY TABLE OF ESP OPERATING
                   PARAMETERS AND PERFORMANCE


                       DATA SET NUMBER   4

                 NON-IDEAL CONDITION SET NUMBER  1

ESP PERFORMANCE:     EFFICIENCY =  94.9491 %     SCA =  2.458E+01 M**2/(M**3/SEC)
                                                       ( 125. FT**2/1000 ACFM)

ELECTRICAL CONDITIONS:     AVG. APPLIED VOLTAGE =  4.377E+04 V
                           AVG. CURRENT DENSITY =   20.01 NA/CM**2
                           RESISTIVITY =  1.000E+09 OHM-CM

SIZE DISTRIBUTIONS:     INLET MMD =  3.302E+00 UM     INLET SIGMAP =  2.164E+00
                        OUTLET MMD =  2.289E+00 UM     OUTLET SIGMAP =  2.144E+00

NONIDEAL PARAMETERS:     GAS SNEAKAGE FRACTION =  .00 /SECTION     GAS VELOCITY SIGMAG =  .00
                         RAPPING MMD =  6.000E+00 UM     RAPPING SIGMAP =  2.500E+00
```

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*************************************
*                                   *
*         E.P.A. ESP MODEL          *
*                                   *
*   I.E.R.L.-R.T.P. AND SO.R.I.     *
*                                   *
*           REVISION III            *
*                                   *
*************************************

PRINTOUT OF INPUT DATA FOR DATA SET NUMBER  5


DATA ON CARD NUMBER   1

NENDPT = 16   NDATA =  4   NRAP =  0   MODL =  0   NOPRNT =  0   PATHL =  0.00 FT   NCOMPS =  0   NWAVES =  0  NLAMDA =  0

DATA ON CARD NUMBER   2

LAB ESP: SCA=125FT2/1000SCFM;J=35 NA/CM2

DATA ON CARD NUMBER   3

VOS( 1) =  4.7600E+04 V  TCS( 1) =  2.0349E-04 A
VOS( 2) =  4.7800E+04 V  TCS( 2) =  2.0349E-04 A
VOS( 3) =  4.6600E+04 V  TCS( 3) =  4.0698E-04 A
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PARTICLE SIZE RANGE STATISTICS

CORRECTIONS FOR NONIDEALITIES USING SET NO.  1 OF CORRECTION PARAMETERS

   SIZE      CCF  INLET % OUTLET % COR. OUTLET % NO-RAP EFF. NO-RAP W  NO-RAP P  COR. EFF.  COR. W      COR. P
2.500E-07  1.590  0.000    0.0011      0.0006       91.8109    10.182    8.1891   91.8109   10.182      8.1891
3.500E-07  1.414  0.400    2.2174      1.1674       91.8702    10.211    8.1298   91.5006   10.030      8.4994
4.500E-07  1.320  0.600    3.1189      1.6592       92.3768    10.473    7.6232   91.9468   10.250      8.0532
5.500E-07  1.261  1.667    7.8247      4.0715       93.1163    10.688    6.8637   92.8871   10.755      7.1129
7.000E-07  1.205  5.000   20.2274     10.5809       94.0672    11.493    5.9328   93.8372   11.336      6.1626
9.000E-07  1.159  4.933   15.9636      8.6012       95.2542    12.401    4.7458   94.9222   12.126      5.0778
1.100E-06  1.130  4.733   12.3614      6.9320       96.1698    13.274    3.8302   95.7347   12.836      4.2653
1.300E-06  1.110  4.000    8.4225      5.0663       96.9121    14.150    3.0679   96.3114   13.427      3.6886
1.600E-06  1.090  8.000   12.5652      6.2403       97.6929    15.336    2.3071   97.0003   14.268      2.9997
2.000E-06  1.072  6.667    7.2489      5.7530       98.4055    16.839    1.5945   97.4870   14.988      2.5130
2.600E-06  1.055 10.667    6.8834      7.8325       99.0537    18.962    0.9463   97.8616   15.645      2.1384
3.500E-06  1.041 10.667    3.0273      6.7083       99.5838    22.304    0.4162   98.1685   16.275      1.8315
5.000E-06  1.029 11.333    0.1160      8.5479       99.9850    35.822    0.0150   97.8034   15.536      2.1966
8.000E-06  1.018 12.000    0.0008     10.4992       99.9999   148.595    0.0001   97.4520   14.932      2.5480
1.500E-05  1.010 19.333    0.0013     14.3396       99.9999   *******    0.0001   97.8399   15.604      2.1601

EFFICIENCIES FOR CONVERGENCE CHECK:  STATED OR PREVIOUS CALCULATION =  94.959   FINAL CALCULATION =  94.958


    ADJUSTED NO-RAP EFF. =  98.5335
    MMD OF INLET SIZE DISTRIBUTION =  3.302E+00
    SIGMAP OF INLET SIZE DISTRIBUTION =  2.164E+00
    LOG-NORMAL GOODNESS OF FIT =  0.935
    MMD OF EFFLUENT UNDER NO-RAP CONDITIONS =  1.137E+00
    SIGMAP OF EFFLUENT UNDER NO-RAP CONDITIONS =  1.545E+00
    LOG-NORMAL GOODNESS OF FIT =  0.963
    PRECIPITATION RATE PARAMETER UNDER NO-RAP CONDITIONS = 17.180

    SIGMAG=    0.000  WITH  0.000 SNEAKAGE OVER    4.000  STAGES
    NTEMP = 1
    RMMD =  6.00
    RSIGMA = 2.50
    CORR. EFF. =  97.0878
    CORRECTED MMD OF EFFLUENT =  2.525E+00
    CORRECTED SIGMAP OF EFFLUENT =  2.237E+00
    LOG-NORMAL GOODNESS OF FIT =  0.905
    CORRECTED PRECIPITATION RATE PARAMETER =   14.39
```

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                              E.P.A. ESP MODEL
                         I.E.R.L.-R.T.P. AND SO.R.I.

                       SUMMARY TABLE OF ESP OPERATING
                          PARAMETERS AND PERFORMANCE


                              DATA SET NUMBER   5

                        NON-IDEAL CONDITION SET NUMBER  1

   ESP PERFORMANCE:     EFFICIENCY =  97.0878 %     SCA =  2.458E+01 M**2/(M**3/SEC)

                                                       ( 125. FT**2/1000 ACFM)

   ELECTRICAL CONDITIONS:     AVG. APPLIED VOLTAGE =  4.720E+04 V

                              AVG. CURRENT DENSITY =   35.01 NA/CM**2

                              RESISTIVITY =  1.000E+09 OHM-CM

   SIZE DISTRIBUTIONS:     INLET MMD =  3.302E+00 UM     INLET SIGMAP =  2.164E+00

                           OUTLET MMD =  2.525E+00 UM     OUTLET SIGMAP =  2.237E+00

   NONIDEAL PARAMETERS:     GAS SNEAKAGE FRACTION =  .00 /SECTION     GAS VELOCITY SIGMAG =  .00

                            RAPPING MMD =  6.000E+00 UM     RAPPING SIGMAP =  2.500E+00

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*                                   *
*         E.P.A. ESP MODEL          *
*    I.E.R.L.-R.T.P. AND SO.R.I.    *
*           REVISION III            *
*                                   *
*************************************

PRINTOUT OF INPUT DATA FOR DATA SET NUMBER  6


DATA ON CARD NUMBER   1

NENOPT = 16   NDATA =  4   NMAP =  0   MODL =  0   NOPRNT =  0   PATHL =  0.00 FT   NCOMPS =  0   NWAVES =  0   NLAMDA =  0

DATA ON CARD NUMBER   2

LAB ESP: SCA=125FT2/1000SCFM;J=45 NA/CM2

DATA ON CARD NUMBER   3

VOS( 1) =  4.9400E+04 V  TCS( 1) =  2.6163E-04 A
VOS( 2) =  4.9400E+04 V  TCS( 2) =  2.6163E-04 A
VOS( 3) =  4.7600E+04 V  TCS( 3) =  5.2326E-04 A
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PARTICLE SIZE RANGE STATISTICS

CORRECTIONS FOR NONIDEALITIES USING SET NO.  1 OF CORRECTION PARAMETERS

   SIZE      CCF  INLET % OUTLET % COR. OUTLET % NO-RAP EFF. NO-RAP W  NO-RAP P  COR. EFF.   COR. W      COR. P
2.500E-07  1.590  0.000   0.0012       0.0005       93.9864     11.438    6.0136   93.9864   11.438      6.0136
3.500E-07  1.414  0.400   2.4499       1.1416       94.0112     11.455    5.9888   93.6965   11.246      6.3035
4.500E-07  1.320  0.000   3.4286       1.6173       94.4125     11.737    5.5875   94.0464   11.479      5.9536
5.500E-07  1.261  1.667   6.5133       3.9161       95.0064     12.194    4.9936   94.8113   12.038      5.1887
7.000E-07  1.205  5.000  21.6600      10.0322       95.7642     12.864    4.2358   95.5683   12.680      4.4317
9.000E-07  1.159  4.933  16.6683       8.0104       96.6961     13.875    3.3039   96.4134   13.541      3.5866
1.100E-06  1.130  4.733  12.5912       6.3679       97.3988     14.848    2.6012   97.0283   14.306      2.9717
1.300E-06  1.110  4.000   8.3653       4.6295       97.9551     15.827    2.0449   97.4437   14.919      2.5563
1.600E-06  1.090  6.000  12.1342       7.5078       98.5169     17.134    1.4831   97.9271   15.772      2.0729
2.000E-06  1.072  6.667   6.7178       5.3345       99.0148     18.796    0.9852   98.2327   16.421      1.7673
2.600E-06  1.055 10.667   5.6102       7.4739       99.4674     21.301    0.5326   98.4524   16.961      1.5476
3.500E-06  1.041 10.667   1.6387       6.5449       99.8498     26.451    0.1502   98.6448   17.501      1.3552
5.000E-06  1.029 11.333   0.0181       9.5366       99.9984     45.029    0.0016   98.1410   16.215      1.8590
8.000E-06  1.018 12.000   0.0012      11.7867       99.9999    213.773    0.0001   97.8305   15.586      2.1695
1.500E-05  1.010 19.333   0.0020      16.0981       99.9999    *******    0.0001   98.1608   16.258      1.8392

EFFICIENCIES FOR CONVERGENCE CHECK:  STATED OR PREVIOUS CALCULATION =  96.043   FINAL CALCULATION =  96.043

   ADJUSTED NO-RAP EFF. =  99.0222
   MMD OF INLET SIZE DISTRIBUTION =  3.302E+00
   SIGMAP OF INLET SIZE DISTRIBUTION =  2.164E+00
   LOG-NORMAL GOODNESS OF FIT =  0.935
   MMD OF EFFLUENT UNDER NO-RAP CONDITIONS =  1.084E+00
   SIGMAP OF EFFLUENT UNDER NO-RAP CONDITIONS =  1.521E+00
   LOG-NORMAL GOODNESS OF FIT =  0.967
   PRECIPITATION RATE PARAMETER UNDER NO-RAP CONDITIONS = 18.829


   SIGMAG=    0.000  WITH  0.000 SNEAKAGE OVER    4.000  STAGES
   NTEMP = 1
   RMMD =  6.00
   RSIGMA = 2.50
   CORR. EFF. =  97.7913
   CORRECTED MMD OF EFFLUENT =  2.682E+00
   CORRECTED SIGMAP OF EFFLUENT =  2.283E+00
   LOG-NORMAL GOODNESS OF FIT =  0.902
   CORRECTED PRECIPITATION RATE PARAMETER =   15.51
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                              E.P.A. ESP MODEL
                         I.E.R.L.-R.T.P. AND SO.R.I.

                        SUMMARY TABLE OF ESP OPERATING
                          PARAMETERS AND PERFORMANCE


                               DATA SET NUMBER    6

                        NON-IDEAL CONDITION SET NUMBER  1

ESP PERFORMANCE:     EFFICIENCY =  97.7913 %      SCA =  2.458E+01 M**2/(M**3/SEC)
                                                         ( 125. FT**2/1000 ACFM)

ELECTRICAL CONDITIONS:     AVG. APPLIED VOLTAGE =  4.650E+04 V
                           AVG. CURRENT DENSITY =   45.01 NA/CM**2
                           RESISTIVITY =  1.000E+09 OHM-CM

SIZE DISTRIBUTIONS:     INLET MMD =  3.302E+00 UM     INLET SIGMAP =  2.164E+00
                        OUTLET MMD =  2.842E+00 UM     OUTLET SIGMAP =  2.283E+00

NONIDEAL PARAMETERS:     GAS SNEAKAGE FRACTION =  .00 /SECTION     GAS VELOCITY SIGMAG =  .00
                         RAPPING MMD =  6.000E+00 UM     RAPPING SIGMAP =  2.500E+00
```

APPENDIX J

OUTPUT DATA FROM EXAMPLE 10

```
                    **************************************
                    *                                    *
                    *          E.P.A. ESP MODEL          *
                    *                                    *
                    *    I.E.R.L.-R.T.P. AND SO.R.I.     *
                    *                                    *
                    *           REVISION III             *
                    *                                    *
                    **************************************

PRINTOUT OF INPUT DATA FOR DATA SET NUMBER  1


DATA ON CARD NUMBER   1

NENDPT = 14   NDATA =  1   NRAP =  0   MODL =  0   NOPRNT =  0   PATHL =  0.00 FT   NCOMPS =  0   NWAVES =  0  NLAMDA =  0

DATA ON CARD NUMBER   2

PLANT A: SCA=243FT2/1000ACFM;VO=41,7KV;CALC. V-I;ANALYSIS OF NONIDEAL EFFECTS

DATA ON CARD NUMBER   3

NEST =  1  NDIST =  1  NVI =  2  NX = 15  NY = 15  NITER =  1  NCALC =  1  NRAPD =  9  NEFF =  1  NTEMP =  1  NUNID =  9

DATA ON CARD NUMBER   4

IFINAL = 20  J11 =  2  J12 = 20  VISKIP = 1  VISAME =  1

DATA ON CARD NUMBER   5

DL =  1,96600 GRN/ACF  PL =  27,0000 FT  ETAU = 99,60000 %  DD =  2270,00 KG/M**3  EPS =  1,000E+02
VRATIO =   1,2000  US =  ,000270 M**2/V-SEC  FPATH =   1,0000  EBD = 1500000, V/M  RHOCGS =  5,00E+10 OHM-CM

DATA ON CARD NUMBER   6

ARD50( 2) =  2,0 UM  ARSIGM( 2) =  2,5
ARD50( 3) = 10,0 UM  ARSIGM( 3) =  2,5
ARD50( 4) = 15,0 UM  ARSIGM( 4) =  2,5
ARD50( 5) = 20,0 UM  ARSIGM( 5) =  2,5
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ARD50( 6) = 10.0 UM  ARSIGM( 6) =  1.5
ARD50( 7) = 10.0 UM  ARSIGM( 7) =  5.0
ARD50( 8) = 10.0 UM  ARSIGM( 8) = 10.0
ARD50( 9) = 10.0 UM  ARSIGM( 9) = 15.0

DATA ON CARD NUMBER   7

ASNUCK( 1) =  .00  AZIGGY( 1) =  .00  AZNUMS( 1) =  4.0
ASNUCK( 2) =  .10  AZIGGY( 2) =  .25  AZNUMS( 2) =  4.0
ASNUCK( 3) =  .30  AZIGGY( 3) =  .25  AZNUMS( 3) =  4.0
ASNUCK( 4) =  .50  AZIGGY( 4) =  .25  AZNUMS( 4) =  4.0
ASNUCK( 5) =  .70  AZIGGY( 5) =  .25  AZNUMS( 5) =  4.0
ASNUCK( 6) =  .10  AZIGGY( 6) =  .10  AZNUMS( 6) =  4.0

DATA ON CARD NUMBER   8

ASNUCK( 7) =  .10  AZIGGY( 7) =  .40  AZNUMS( 7) =  4.0
ASNUCK( 8) =  .10  AZIGGY( 8) =  .60  AZNUMS( 8) =  4.0
ASNUCK( 9) =  .10  AZIGGY( 9) =  .80  AZNUMS( 9) =  4.0

DATA ON CARD NUMBER   9

ENDPT( 1) =    0.100 UM   ENDPT( 2) =    0.300 UM   ENDPT( 3) =    0.500 UM   ENDPT( 4) =    0.900 UM   ENDPT( 5) =    1.300 UM
ENDPT( 6) =    1.900 UM   ENDPT( 7) =    3.100 UM   ENDPT( 8) =    3.900 UM   ENDPT( 9) =    5.100 UM   ENDPT(10) =    6.900 UM

DATA ON CARD NUMBER  10

ENDPT(11) =   10.100 UM   ENDPT(12) =   14.900 UM   ENDPT(13) =   25.100 UM   ENDPT(14) =   29.900 UM

DATA ON CARD NUMBER  11

PRCU( 1) =   0.0000 %   PRCU( 2) =   0.0330 %   PRCU( 3) =   0.2860 %   PRCU( 4) =   1.1890 %   PRCU( 5) =   2.0040 %
PRCU( 6) =   3.5240 %   PRCU( 7) =   7.0480 %   PRCU( 8) =   8.7000 %   PRCU( 9) =  10.3520 %   PRCU(10) =  12.3340 %
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DATA ON CARD NUMBER  12

PRCU(11) =  15.6380 %   PRCU(12) =  20.4840 %   PRCU(13) =  32.5990 %   PRCU(14) = 100.0000 %

DATA ON CARD NUMBER  13

NUMSEC =  3    LSECT( 1) = 15  LSECT( 2) = 15  LSECT( 3) = 15

DATA ON CARD NUMBER  14

AS( 1) =  2.6460E+04 FT**2  VOS( 1) =  4.1700E+04 V  TCS( 1) =  2.7300E-01 A  WLS( 1) =  1.5720E+04 FT
ACS( 1) =  8.2500E-02 IN  BS( 1) =  5.5000E+00 IN  NWS( 1) =  1.2000E+01

DATA ON CARD NUMBER  15

SYS( 1) =  3.6000E+00 IN  VGS( 1) =  3.2724E+05 FT**3/MIN  VGASS( 1) =  4.1000E+00 FT/SEC  TEMPS( 1) =  3.1500E+02 F
PS( 1) =  1.0000E+00 ATM  VISS( 1) =  2.2900E-05 KG/M-SEC  LINCS( 1) =  6.0000E-01 FT

DATA ON CARD NUMBER  16

RFS( 1) =  8.5000E-01  START1( 1) =  1.0000E-04 A/M**2  START2( 1) =  5.0000E-05 A/M**2
START3( 1) =  5.0000E-05 A/M**2  VSTAR( 1) =  3.6000E+04 V

DATA ON CARD NUMBER  17

AS( 2) =  2.6460E+04 FT**2  VOS( 2) =  4.1700E+04 V  TCS( 2) =  2.7300E-01 A  WLS( 2) =  1.5720E+04 FT
ACS( 2) =  8.2500E-02 IN  BS( 2) =  5.5000E+00 IN  NWS( 2) =  1.2000E+01

DATA ON CARD NUMBER  18

SYS( 2) =  3.6000E+00 IN  VGS( 2) =  3.2724E+05 FT**3/MIN  VGASS( 2) =  4.1000E+00 FT/SEC  TEMPS( 2) =  3.1500E+02 F
PS( 2) =  1.0000E+00 ATM  VISS( 2) =  2.2900E-05 KG/M-SEC  LINCS( 2) =  6.0000E-01 FT

DATA ON CARD NUMBER  19

RFS( 2) =  8.5000E-01  START1( 2) =  1.0000E-04 A/M**2  START2( 2) =  5.0000E-05 A/M**2
START3( 2) =  5.0000E-05 A/M**2  VSTAR( 2) =  3.6000E+04 V
```

```
DATA ON CARD NUMBER  20

AS( 3) =  2.6460E+04 FT**2  VOS( 3) =  4.1700E+04 V  TCS( 3) =  2.7300E-01 A  WLS( 3) =  1.5720E+04 FT

ACS( 3) =  8.2500E-02 IN  BS( 3) =  5.5000E+00 IN  NWS( 3) =  1.2000E+01

DATA ON CARD NUMBER  21

SYS( 3) =  3.6000E+00 IN  VGS( 3) =  3.2724E+05 FT**3/MIN  VGASS( 3) =  4.1000E+00 FT/SEC  TEMPS( 3) =  3.1500E+02 F

PS( 3) =  1.0000E+00 ATM  VISS( 3) =  2.2900E-05 KG/M-SEC  LINCS( 3) =  6.0000E-01 FT

DATA ON CARD NUMBER  22

RFS( 3) =  8.5000E-01  START1( 3) =  1.0000E-04 A/M**2  START2( 3) =  5.0000E-05 A/M**2

START3( 3) =  5.0000E-05 A/M**2  VSTAR( 3) =  3.6000E+04 V
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CLEAN GAS VOLTAGE-CURRENT DENSITY-FIELD AT THE PLATE RELATIONSHIP FOR SECTION NO.  1

                     VW = -3,7222E+04  ACDNTY =  9,9485E-05  AEPLT = -1,4263E+05
                     VW = -3,8360E+04  ACDNTY =  1,4871E-04  AEPLT = -1,5453E+05
                     VW = -3,9346E+04  ACDNTY =  1,9820E-04  AEPLT = -1,6570E+05
                     VW = -4,0258E+04  ACDNTY =  2,4771E-04  AEPLT = -1,7606E+05
                     VW = -4,1082E+04  ACDNTY =  2,9707E-04  AEPLT = -1,8570E+05
                     VW = -4,1892E+04  ACDNTY =  3,4668E-04  AEPLT = -1,9489E+05
                     VW = -4,1700E+04  ACDNTY =  3,3384E-04  AEPLT = -1,9342E+05


INCREMENTAL ANALYSIS OF PRECIPITATOR PERFORMANCE


PLANT A: SCA=243FT2/1000ACFM;VO=41,7KV;CALC. V-I;ANALYSIS OF NONIDEAL EFFECTS


CALCULATION IS IN SECTION NO. = 1 AND THE SECTION LENGTH IS =  2,7450 M

COLLECTION AREA =  2,461E+03 M2        APPLIED VOLTAGE =  4,170E+04 VOLTS        TOTAL CURRENT =  8,215E-01 AMPS
WIRE TO PLATE =  1,397E-01 M           CORONA WIRE RADIUS =  2,095E-03 M         CORONA WIRE LENGTH =  4,795E+03 M
CURRENT/M =  1,713E-04 AMP/M           CURRENT DENSITY =  3,338E-04 AMP/M2       DEPOSIT E FIELD =  1,669E+05 VOLT/M
1/2 WIRE TO WIRE =  9,144E-02 M        GAS FLOW RATE =  1,548E+02 M3/SEC         GAS VELOCITY =  1,251E+00 M/SEC
TEMPERATURE = 430,000 K                PRESSURE =   1,000 ATM                    VISCOSITY =  2,290E-05 KG/M-SEC
ION MOBILITY =  4,250E-04 M2/VOLT-SEC  MEAN THERMAL SPEED =  5,335E+02 M/SEC     PART. PATH PARAM. =  8,246E-08 M
DUST WEIGHT =  6,969E-01 KG/SEC        LENGTH INCR. = ,18300000 M                INPUT EFF./INCR. = 11,55

RIOVR    EMAVG       EPLT        AFID       CMCD     MMD         WEIGHT     DUST LAYER   J(PART)      J(ION)   INCR. NO.

 ,4000  1,771E+05  1,9342E+05  1,8145E+13   13,4   2,29E-05   1,256E-03   7,110E-02   9,27E-07   3,33E-04      1
 ,3423  1,771E+05  1,9342E+05  1,8179E+13   11,4   2,04E-05   1,151E-03   6,513E-02   1,20E-06   3,33E-04      2
 ,3516  1,771E+05  1,9342E+05  1,8190E+13   11,7   1,36E-05   7,218E-04   4,086E-02   9,83E-07   3,33E-04      3
 ,3648  1,771E+05  1,9342E+05  1,8196E+13   12,2   8,06E-06   4,311E-04   2,440E-02   7,83E-07   3,33E-04      4
 ,3783  1,771E+05  1,9342E+05  1,8199E+13   12,6   4,20E-06   2,572E-04   1,456E-02   6,40E-07   3,33E-04      5
 ,3913  1,771E+05  1,9342E+05  1,8201E+13   13,1   2,27E-06   1,576E-04   8,922E-03   5,43E-07   3,33E-04      6
 ,4041  1,771E+05  1,9342E+05  1,8203E+13   13,5   1,70E-06   1,011E-04   5,722E-03   4,77E-07   3,33E-04      7
 ,4168  1,771E+05  1,9342E+05  1,8204E+13   13,9   1,31E-06   6,865E-05   3,886E-03   4,29E-07   3,33E-04      8
 ,4295  1,771E+05  1,9342E+05  1,8205E+13   14,3   1,03E-06   4,951E-05   2,803E-03   3,92E-07   3,33E-04      9
 ,4422  1,771E+05  1,9342E+05  1,8205E+13   14,8   7,76E-07   3,773E-05   2,136E-03   3,62E-07   3,33E-04     10
 ,4549  1,771E+05  1,9342E+05  1,8206E+13   15,2   6,40E-07   3,008E-05   1,703E-03   3,37E-07   3,34E-04     11
 ,4677  1,771E+05  1,9342E+05  1,8207E+13   15,6   5,63E-07   2,483E-05   1,406E-03   3,15E-07   3,34E-04     12
 ,4805  1,771E+05  1,9342E+05  1,8207E+13   16,0   5,10E-07   2,103E-05   1,190E-03   2,95E-07   3,34E-04     13
 ,4933  1,771E+05  1,9342E+05  1,8207E+13   16,5   4,73E-07   1,813E-05   1,026E-03   2,77E-07   3,34E-04     14
 ,5062  1,771E+05  1,9342E+05  1,8208E+13   16,9   4,44E-07   1,582E-05   8,958E-04   2,60E-07   3,34E-04     15

CALCULATION IS IN SECTION NO. = 2 AND THE SECTION LENGTH IS =  2,7450 M

COLLECTION AREA =  2,461E+03 M2        APPLIED VOLTAGE =  4,170E+04 VOLTS        TOTAL CURRENT =  8,215E-01 AMPS
WIRE TO PLATE =  1,397E-01 M           CORONA WIRE RADIUS =  2,095E-03 M         CORONA WIRE LENGTH =  4,795E+03 M
CURRENT/M =  1,713E-04 AMP/M           CURRENT DENSITY =  3,338E-04 AMP/M2       DEPOSIT E FIELD =  1,669E+05 VOLT/M
1/2 WIRE TO WIRE =  9,144E-02 M        GAS FLOW RATE =  1,548E+02 M3/SEC         GAS VELOCITY =  1,251E+00 M/SEC
TEMPERATURE = 430,000 K                PRESSURE =   1,000 ATM                    VISCOSITY =  2,290E-05 KG/M-SEC
ION MOBILITY =  4,250E-04 M2/VOLT-SEC  MEAN THERMAL SPEED =  5,335E+02 M/SEC     PART. PATH PARAM. =  8,246E-08 M
DUST WEIGHT =  6,969E-01 KG/SEC        LENGTH INCR. = ,18300000 M                INPUT EFF./INCR. = 11,55
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RIOVR    EHAVG      EPLT        AFID      CMCD     MMD       WEIGHT     DUST LAYER   J(PART)     J(ION)    INCR. NO.

 .5191  1.771E+05  1.9342E+05  1.8208E+13   17.3   4.23E-07   1.394E-05   7.891E-04   2.45E-07   3.34E-04     16
 .5321  1.771E+05  1.9342E+05  1.8208E+13   17.8   4.06E-07   1.237E-05   7.001E-04   2.30E-07   3.34E-04     17
 .5450  1.771E+05  1.9342E+05  1.8208E+13   18.2   3.79E-07   1.104E-05   6.240E-04   2.16E-07   3.34E-04     18
 .5581  1.771E+05  1.9342E+05  1.8209E+13   18.6   3.50E-07   9.896E-06   5.602E-04   2.03E-07   3.34E-04     19
 .5712  1.771E+05  1.9342E+05  1.8209E+13   19.1   3.26E-07   8.910E-06   5.044E-04   1.91E-07   3.34E-04     20
 .5842  1.771E+05  1.9342E+05  1.8209E+13   19.5   3.06E-07   8.050E-06   4.557E-04   1.79E-07   3.34E-04     21
 .5971  1.771E+05  1.9342E+05  1.8210E+13   19.9   2.90E-07   7.297E-06   4.131E-04   1.68E-07   3.34E-04     22
 .6098  1.771E+05  1.9342E+05  1.8210E+13   20.4   2.76E-07   6.632E-06   3.754E-04   1.58E-07   3.34E-04     23
 .6223  1.771E+05  1.9342E+05  1.8210E+13   20.8   2.64E-07   6.042E-06   3.421E-04   1.49E-07   3.34E-04     24
 .6346  1.771E+05  1.9342E+05  1.8210E+13   21.2   2.54E-07   5.517E-06   3.123E-04   1.40E-07   3.34E-04     25
 .6467  1.771E+05  1.9342E+05  1.8210E+13   21.6   2.45E-07   5.048E-06   2.856E-04   1.32E-07   3.34E-04     26
 .6584  1.771E+05  1.9342E+05  1.8210E+13   22.0   2.37E-07   4.628E-06   2.620E-04   1.25E-07   3.34E-04     27
 .6700  1.771E+05  1.9342E+05  1.8210E+13   22.4   2.31E-07   4.249E-06   2.405E-04   1.18E-07   3.34E-04     28
 .6812  1.771E+05  1.9342E+05  1.8210E+13   22.7   2.25E-07   3.908E-06   2.212E-04   1.11E-07   3.34E-04     29
 .6922  1.771E+05  1.9342E+05  1.8210E+13   23.1   2.20E-07   3.599E-06   2.037E-04   1.05E-07   3.34E-04     30

CALCULATION IS IN SECTION NO. = 3 AND THE SECTION LENGTH IS =  2.7450 M

COLLECTION AREA =  2.461E+03 M2         APPLIED VOLTAGE =  4.170E+04 VOLTS         TOTAL CURRENT =  8.215E-01 AMPS
WIRE TO PLATE =  1.397E-01 M            CORONA WIRE RADIUS =  2.095E-03 M          CORONA WIRE LENGTH =  4.795E+03 M
CURRENT/M =  1.713E-04 AMP/M            CURRENT DENSITY =  3.338E-04 AMP/M2        DEPOSIT E FIELD =  1.669E+05 VOLT/M
1/2 WIRE TO WIRE =  9.144E-02 M         GAS FLOW RATE =  1.548E+02 M3/SEC          GAS VELOCITY =  1.251E+00 M/SEC
TEMPERATURE = 430.000 K                 PRESSURE =   1.000 ATM                     VISCOSITY =  2.290E-05 KG/M-SEC
ION MOBILITY =  4.250E-04 M2/VOLT-SEC  MEAN THERMAL SPEED =  5.335E+02 M/SEC      PART. PATH PARAM. =  8.246E-08 M
DUST WEIGHT =  6.969E-01 KG/SEC         LENGTH INCR. = .18300000 M                 INPUT EFF./INCR. = 11.55

RIOVR    EHAVG      EPLT        AFID      CMCD     MMD       WEIGHT     DUST LAYER   J(PART)     J(ION)    INCR. NO.

 .7029  1.771E+05  1.9342E+05  1.8210E+13   23.5   2.15E-07   3.319E-06   1.879E-04   9.91E-08   3.34E-04     31
 .7134  1.771E+05  1.9342E+05  1.8210E+13   23.8   2.11E-07   3.064E-06   1.735E-04   9.37E-08   3.34E-04     32
 .7235  1.771E+05  1.9342E+05  1.8210E+13   24.2   2.08E-07   2.833E-06   1.604E-04   8.86E-08   3.34E-04     33
 .7334  1.771E+05  1.9342E+05  1.8210E+13   24.5   2.05E-07   2.622E-06   1.484E-04   8.38E-08   3.34E-04     34
 .7431  1.771E+05  1.9342E+05  1.8210E+13   24.8   2.02E-07   2.429E-06   1.375E-04   7.94E-08   3.34E-04     35
 .7524  1.771E+05  1.9342E+05  1.8210E+13   25.1   2.00E-07   2.252E-06   1.275E-04   7.52E-08   3.34E-04     36
 .7615  1.771E+05  1.9342E+05  1.8210E+13   25.4   2.00E-07   2.090E-06   1.183E-04   7.12E-08   3.34E-04     37
 .7703  1.771E+05  1.9342E+05  1.8210E+13   25.7   2.00E-07   1.942E-06   1.099E-04   6.75E-08   3.34E-04     38
 .7789  1.771E+05  1.9342E+05  1.8210E+13   26.0   2.00E-07   1.806E-06   1.022E-04   6.40E-08   3.34E-04     39
 .7872  1.771E+05  1.9342E+05  1.8210E+13   26.3   2.00E-07   1.680E-06   9.513E-05   6.07E-08   3.34E-04     40
 .7952  1.771E+05  1.9342E+05  1.8210E+13   26.6   2.00E-07   1.565E-06   8.860E-05   5.76E-08   3.34E-04     41
 .8030  1.771E+05  1.9342E+05  1.8210E+13   26.8   2.00E-07   1.459E-06   8.258E-05   5.46E-08   3.34E-04     42
 .8105  1.771E+05  1.9342E+05  1.8210E+13   27.1   2.00E-07   1.360E-06   7.702E-05   5.19E-08   3.34E-04     43
 .8178  1.771E+05  1.9342E+05  1.8210E+13   27.3   2.00E-07   1.270E-06   7.188E-05   4.92E-08   3.34E-04     44
 .8249  1.771E+05  1.9342E+05  1.8210E+13   27.5   2.00E-07   1.186E-06   6.714E-05   4.66E-08   3.34E-04     45

DESIGN EFFICIENCY = 99.60     UNCORRECTED COMPUTED EFFICIENCY = 99.58
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CHARGING RATES FOR PARTICLE SIZES FROM SUBROUTINE CHARGN OR CHGSUM

SUM OF CLASSICAL FIELD AND DIFFUSIONAL CHARGES USED FOR PARTICLE CHARGING

INCREMENT NO.     Q/QSATF FOR INDICATED PARTICLE SIZES

   0.2000E-06   0.4000E-06   0.7000E-06   0.1100E-05   0.1600E-05   0.2500E-05   0.3500E-05   0.4500E-05
 1  1.4708        1.2986       1.1177       0.9956       0.9167       0.8463       0.8070       0.7837
 2  1.7105        1.4854       1.2660       1.1219       1.0302       0.9494       0.9047       0.8785
 3  1.8471        1.5905       1.3483       1.1912       1.0920       1.0052       0.9573       0.9293
 4  1.9410        1.6618       1.4034       1.2372       1.1327       1.0414       0.9914       0.9621
 5  2.0117        1.7149       1.4440       1.2706       1.1619       1.0673       1.0155       0.9853
 6  2.0680        1.7568       1.4756       1.2963       1.1843       1.0870       1.0338       1.0028
 7  2.1146        1.7912       1.5013       1.3171       1.2022       1.1025       1.0482       1.0165
 8  2.1543        1.8203       1.5228       1.3344       1.2170       1.1153       1.0599       1.0277
 9  2.1869        1.8455       1.5414       1.3491       1.2295       1.1261       1.0698       1.0370
10  2.2194        1.8676       1.5576       1.3619       1.2404       1.1354       1.0782       1.0450
11  2.2467        1.8874       1.5720       1.3733       1.2500       1.1435       1.0856       1.0520
12  2.2715        1.9053       1.5849       1.3834       1.2585       1.1507       1.0922       1.0582
13  2.2942        1.9216       1.5967       1.3926       1.2662       1.1572       1.0980       1.0637
14  2.3150        1.9365       1.6074       1.4010       1.2732       1.1631       1.1033       1.0687
15  2.3343        1.9503       1.6173       1.4087       1.2796       1.1685       1.1033       1.0687
16  2.3523        1.9631       1.6265       1.4157       1.2855       1.1685       1.1033       1.0687
17  2.3691        1.9751       1.6350       1.4223       1.2855       1.1685       1.1033       1.0687
18  2.3848        1.9863       1.6429       1.4223       1.2855       1.1685       1.1033       1.0687
19  2.3996        1.9968       1.6429       1.4223       1.2855       1.1685       1.1033       1.0687
20  2.4136        2.0067       1.6429       1.4223       1.2855       1.1685       1.1033       1.0687
21  2.4268        2.0067       1.6429       1.4223       1.2855       1.1685       1.1033       1.0687
22  2.4394        2.0067       1.6429       1.4223       1.2855       1.1685       1.1033       1.0687
23  2.4514        2.0067       1.6429       1.4223       1.2855       1.1685       1.1033       1.0687
24  2.4514        2.0067       1.6429       1.4223       1.2855       1.1685       1.1033       1.0687
25  2.4514        2.0067       1.6429       1.4223       1.2855       1.1685       1.1033       1.0687
26  2.4514        2.0067       1.6429       1.4223       1.2855       1.1685       1.1033       1.0687
27  2.4514        2.0067       1.6429       1.4223       1.2855       1.1685       1.1033       1.0687
28  2.4514        2.0067       1.6429       1.4223       1.2855       1.1685       1.1033       1.0687
29  2.4514        2.0067       1.6429       1.4223       1.2855       1.1685       1.1033       1.0687
30  2.4514        2.0067       1.6429       1.4223       1.2855       1.1685       1.1033       1.0687
31  2.4514        2.0067       1.6429       1.4223       1.2855       1.1685       1.1033       1.0687
32  2.4514        2.0067       1.6429       1.4223       1.2855       1.1685       1.1033       1.0687
33  2.4514        2.0067       1.6429       1.4223       1.2855       1.1685       1.1033       1.0687
34  2.4514        2.0067       1.6429       1.4223       1.2855       1.1685       1.1033       1.0687
35  2.4514        2.0067       1.6429       1.4223       1.2855       1.1685       1.1033       1.0687
36  2.4514        2.0067       1.6429       1.4223       1.2855       1.1685       1.1033       1.0687
37  2.4514        2.0067       1.6429       1.4223       1.2855       1.1685       1.1033       1.0687
38  2.4514        2.0067       1.6429       1.4223       1.2855       1.1685       1.1033       1.0687
39  2.4514        2.0067       1.6429       1.4223       1.2855       1.1685       1.1033       1.0687
40  2.4514        2.0067       1.6429       1.4223       1.2855       1.1685       1.1033       1.0687
41  2.4514        2.0067       1.6429       1.4223       1.2855       1.1685       1.1033       1.0687
42  2.4514        2.0067       1.6429       1.4223       1.2855       1.1685       1.1033       1.0687
43  2.4514        2.0067       1.6429       1.4223       1.2855       1.1685       1.1033       1.0687
44  2.4514        2.0067       1.6429       1.4223       1.2855       1.1685       1.1033       1.0687
45  2.4514        2.0067       1.6429       1.4223       1.2855       1.1685       1.1033       1.0687

    0.6000E-05   0.8500E-05   0.1250E-04   0.2000E-04   0.2750E-04
```

1	0.7623	0.7423	0.7260	0.7121	0.7053
2	0.8544	0.8321	0.8140	0.7987	0.7913
3	0.9038	0.8801	0.8610	0.8448	0.8371
4	0.9355	0.9108	0.8910	0.8742	0.8663
5	0.9578	0.9324	0.9120	0.8948	0.8866
6	0.9746	0.9486	0.9276	0.9101	0.9017
7	0.9877	0.9612	0.9399	0.9220	0.9135
8	0.9984	0.9714	0.9497	0.9316	0.9240
9	1.0073	0.9799	0.9580	0.9396	0.9308
10	1.0149	0.9872	0.9649	0.9463	0.9375
11	1.0215	0.9935	0.9710	0.9522	0.9432
12	1.0273	0.9990	0.9763	0.9573	0.9483
13	1.0326	1.0040	0.9810	0.9619	0.9528
14	1.0373	1.0040	0.9810	0.9619	0.9528
15	1.0373	1.0040	0.9810	0.9619	0.9528
16	1.0373	1.0040	0.9810	0.9619	0.9528
17	1.0373	1.0040	0.9810	0.9619	0.9528
18	1.0373	1.0040	0.9810	0.9619	0.9528
19	1.0373	1.0040	0.9810	0.9619	0.9528
20	1.0373	1.0040	0.9810	0.9619	0.9528
21	1.0373	1.0040	0.9810	0.9619	0.9528
22	1.0373	1.0040	0.9810	0.9619	0.9528
23	1.0373	1.0040	0.9810	0.9619	0.9528
24	1.0373	1.0040	0.9810	0.9619	0.9528
25	1.0373	1.0040	0.9810	0.9619	0.9528
26	1.0373	1.0040	0.9810	0.9619	0.9528
27	1.0373	1.0040	0.9810	0.9619	0.9528
28	1.0373	1.0040	0.9810	0.9619	0.9528
29	1.0373	1.0040	0.9810	0.9619	0.9528
30	1.0373	1.0040	0.9810	0.9619	0.9528
31	1.0373	1.0040	0.9810	0.9619	0.9528
32	1.0373	1.0040	0.9810	0.9619	0.9528
33	1.0373	1.0040	0.9810	0.9619	0.9528
34	1.0373	1.0040	0.9810	0.9619	0.9528
35	1.0373	1.0040	0.9810	0.9619	0.9528
36	1.0373	1.0040	0.9810	0.9619	0.9528
37	1.0373	1.0040	0.9810	0.9619	0.9528
38	1.0373	1.0040	0.9810	0.9619	0.9528
39	1.0373	1.0040	0.9810	0.9619	0.9528
40	1.0373	1.0040	0.9810	0.9619	0.9528
41	1.0373	1.0040	0.9810	0.9619	0.9528
42	1.0373	1.0040	0.9810	0.9619	0.9528
43	1.0373	1.0040	0.9810	0.9619	0.9528
44	1.0373	1.0040	0.9810	0.9619	0.9528
45	1.0373	1.0040	0.9810	0.9619	0.9528

```
CHARGE ACCUMULATED ON PARTICLE SIZES IN EACH INCREMENT

INCREMENT        CHARGE FOR INDICATED PARTICLE SIZES

         0.2000E-06   0.4000E-06   0.7000E-06   0.1100E-05   0.1600E-05   0.2500E-05   0.3500E-05   0.4500E-05
   1    0.26394E-17  0.71469E-17  0.17326E-16  0.37036E-16  0.71336E-16  0.15975E-15  0.29785E-15  0.47768E-15
   2    0.30696E-17  0.81774E-17  0.19625E-16  0.41735E-16  0.80170E-16  0.17921E-15  0.33393E-15  0.53543E-15
   3    0.33148E-17  0.87557E-17  0.20901E-16  0.44315E-16  0.84985E-16  0.18974E-15  0.35335E-15  0.56644E-15
   4    0.34833E-17  0.91484E-17  0.21756E-16  0.46024E-16  0.88145E-16  0.19659E-15  0.36592E-15  0.58643E-15
   5    0.36102E-17  0.94407E-17  0.22384E-16  0.47266E-16  0.90421E-16  0.20147E-15  0.37483E-15  0.60057E-15
   6    0.37112E-17  0.96714E-17  0.22874E-16  0.48225E-16  0.92163E-16  0.20518E-15  0.38156E-15  0.61120E-15
   7    0.37949E-17  0.98608E-17  0.23273E-16  0.48997E-16  0.93556E-16  0.20812E-15  0.38687E-15  0.61956E-15
   8    0.38661E-17  0.10021E-16  0.23607E-16  0.49640E-16  0.94708E-16  0.21054E-15  0.39121E-15  0.62637E-15
   9    0.39281E-17  0.10160E-16  0.23894E-16  0.50188E-16  0.95685E-16  0.21257E-15  0.39485E-15  0.63207E-15
  10    0.39829E-17  0.10282E-16  0.24145E-16  0.50665E-16  0.96530E-16  0.21432E-15  0.39797E-15  0.63695E-15
  11    0.40320E-17  0.10391E-16  0.24368E-16  0.51086E-16  0.97274E-16  0.21585E-15  0.40070E-15  0.64120E-15
  12    0.40765E-17  0.10489E-16  0.24569E-16  0.51464E-16  0.97939E-16  0.21722E-15  0.40312E-15  0.64496E-15
  13    0.41171E-17  0.10579E-16  0.24751E-16  0.51806E-16  0.98538E-16  0.21844E-15  0.40528E-15  0.64833E-15
  14    0.41545E-17  0.10661E-16  0.24918E-16  0.52118E-16  0.99083E-16  0.21955E-15  0.40724E-15  0.65137E-15
  15    0.41892E-17  0.10737E-16  0.25071E-16  0.52404E-16  0.99582E-16  0.22057E-15  0.40724E-15  0.65137E-15
  16    0.42214E-17  0.10807E-16  0.25213E-16  0.52667E-16  0.10004E-15  0.22057E-15  0.40724E-15  0.65137E-15
  17    0.42515E-17  0.10873E-16  0.25345E-16  0.52911E-16  0.10004E-15  0.22057E-15  0.40724E-15  0.65137E-15
  18    0.42797E-17  0.10935E-16  0.25469E-16  0.52911E-16  0.10004E-15  0.22057E-15  0.40724E-15  0.65137E-15
  19    0.43063E-17  0.10993E-16  0.25469E-16  0.52911E-16  0.10004E-15  0.22057E-15  0.40724E-15  0.65137E-15
  20    0.43314E-17  0.11047E-16  0.25469E-16  0.52911E-16  0.10004E-15  0.22057E-15  0.40724E-15  0.65137E-15
  21    0.43552E-17  0.11047E-16  0.25469E-16  0.52911E-16  0.10004E-15  0.22057E-15  0.40724E-15  0.65137E-15
  22    0.43777E-17  0.11047E-16  0.25469E-16  0.52911E-16  0.10004E-15  0.22057E-15  0.40724E-15  0.65137E-15
  23    0.43992E-17  0.11047E-16  0.25469E-16  0.52911E-16  0.10004E-15  0.22057E-15  0.40724E-15  0.65137E-15
  24    0.43992E-17  0.11047E-16  0.25469E-16  0.52911E-16  0.10004E-15  0.22057E-15  0.40724E-15  0.65137E-15
  25    0.43992E-17  0.11047E-16  0.25469E-16  0.52911E-16  0.10004E-15  0.22057E-15  0.40724E-15  0.65137E-15
  26    0.43992E-17  0.11047E-16  0.25469E-16  0.52911E-16  0.10004E-15  0.22057E-15  0.40724E-15  0.65137E-15
  27    0.43992E-17  0.11047E-16  0.25469E-16  0.52911E-16  0.10004E-15  0.22057E-15  0.40724E-15  0.65137E-15
  28    0.43992E-17  0.11047E-16  0.25469E-16  0.52911E-16  0.10004E-15  0.22057E-15  0.40724E-15  0.65137E-15
  29    0.43992E-17  0.11047E-16  0.25469E-16  0.52911E-16  0.10004E-15  0.22057E-15  0.40724E-15  0.65137E-15
  30    0.43992E-17  0.11047E-16  0.25469E-16  0.52911E-16  0.10004E-15  0.22057E-15  0.40724E-15  0.65137E-15
  31    0.43992E-17  0.11047E-16  0.25469E-16  0.52911E-16  0.10004E-15  0.22057E-15  0.40724E-15  0.65137E-15
  32    0.43992E-17  0.11047E-16  0.25469E-16  0.52911E-16  0.10004E-15  0.22057E-15  0.40724E-15  0.65137E-15
  33    0.43992E-17  0.11047E-16  0.25469E-16  0.52911E-16  0.10004E-15  0.22057E-15  0.40724E-15  0.65137E-15
  34    0.43992E-17  0.11047E-16  0.25469E-16  0.52911E-16  0.10004E-15  0.22057E-15  0.40724E-15  0.65137E-15
  35    0.43992E-17  0.11047E-16  0.25469E-16  0.52911E-16  0.10004E-15  0.22057E-15  0.40724E-15  0.65137E-15
  36    0.43992E-17  0.11047E-16  0.25469E-16  0.52911E-16  0.10004E-15  0.22057E-15  0.40724E-15  0.65137E-15
  37    0.43992E-17  0.11047E-16  0.25469E-16  0.52911E-16  0.10004E-15  0.22057E-15  0.40724E-15  0.65137E-15
  38    0.43992E-17  0.11047E-16  0.25469E-16  0.52911E-16  0.10004E-15  0.22057E-15  0.40724E-15  0.65137E-15
  39    0.43992E-17  0.11047E-16  0.25469E-16  0.52911E-16  0.10004E-15  0.22057E-15  0.40724E-15  0.65137E-15
  40    0.43992E-17  0.11047E-16  0.25469E-16  0.52911E-16  0.10004E-15  0.22057E-15  0.40724E-15  0.65137E-15
  41    0.43992E-17  0.11047E-16  0.25469E-16  0.52911E-16  0.10004E-15  0.22057E-15  0.40724E-15  0.65137E-15
  42    0.43992E-17  0.11047E-16  0.25469E-16  0.52911E-16  0.10004E-15  0.22057E-15  0.40724E-15  0.65137E-15
  43    0.43992E-17  0.11047E-16  0.25469E-16  0.52911E-16  0.10004E-15  0.22057E-15  0.40724E-15  0.65137E-15
  44    0.43992E-17  0.11047E-16  0.25469E-16  0.52911E-16  0.10004E-15  0.22057E-15  0.40724E-15  0.65137E-15
  45    0.43992E-17  0.11047E-16  0.25469E-16  0.52911E-16  0.10004E-15  0.22057E-15  0.40724E-15  0.65137E-15

         0.6000E-05   0.8500E-05   0.1250E-04   0.2000E-04   0.2750E-04
   1    0.82538E-15  0.16122E-14  0.34089E-14  0.85584E-14  0.16028E-13
   2    0.92513E-15  0.18073E-14  0.38222E-14  0.95991E-14  0.17980E-13
   3    0.97856E-15  0.19115E-14  0.40426E-14  0.10153E-13  0.19019E-13
   4    0.10129E-14  0.19782E-14  0.41835E-14  0.10507E-13  0.19681E-13
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 5   0.10371E-14   0.20251E-14   0.42821E-14   0.10754E-13   0.20113E-13
 6   0.10552E-14   0.20602E-14   0.43557E-14   0.10937E-13   0.20487E-13
 7   0.10694E-14   0.20876E-14   0.44131E-14   0.11080E-13   0.20754E-13
 8   0.10810E-14   0.21098E-14   0.44595E-14   0.11196E-13   0.20969E-13
 9   0.10906E-14   0.21283E-14   0.44980E-14   0.11291E-13   0.21148E-13
10   0.10989E-14   0.21440E-14   0.45307E-14   0.11373E-13   0.21299E-13
11   0.11060E-14   0.21577E-14   0.45591E-14   0.11443E-13   0.21430E-13
12   0.11123E-14   0.21697E-14   0.45841E-14   0.11505E-13   0.21545E-13
13   0.11180E-14   0.21805E-14   0.46064E-14   0.11560E-13   0.21647E-13
14   0.11231E-14   0.21805E-14   0.46064E-14   0.11560E-13   0.21647E-13
15   0.11231E-14   0.21805E-14   0.46064E-14   0.11560E-13   0.21647E-13
16   0.11231E-14   0.21805E-14   0.46064E-14   0.11560E-13   0.21647E-13
17   0.11231E-14   0.21805E-14   0.46064E-14   0.11560E-13   0.21647E-13
18   0.11231E-14   0.21805E-14   0.46064E-14   0.11560E-13   0.21647E-13
19   0.11231E-14   0.21805E-14   0.46064E-14   0.11560E-13   0.21647E-13
20   0.11231E-14   0.21805E-14   0.46064E-14   0.11560E-13   0.21647E-13
21   0.11231E-14   0.21805E-14   0.46064E-14   0.11560E-13   0.21647E-13
22   0.11231E-14   0.21805E-14   0.46064E-14   0.11560E-13   0.21647E-13
23   0.11231E-14   0.21805E-14   0.46064E-14   0.11560E-13   0.21647E-13
24   0.11231E-14   0.21805E-14   0.46064E-14   0.11560E-13   0.21647E-13
25   0.11231E-14   0.21805E-14   0.46064E-14   0.11560E-13   0.21647E-13
26   0.11231E-14   0.21805E-14   0.46064E-14   0.11560E-13   0.21647E-13
27   0.11231E-14   0.21805E-14   0.46064E-14   0.11560E-13   0.21647E-13
28   0.11231E-14   0.21805E-14   0.46064E-14   0.11560E-13   0.21647E-13
29   0.11231E-14   0.21805E-14   0.46064E-14   0.11560E-13   0.21647E-13
30   0.11231E-14   0.21805E-14   0.46064E-14   0.11560E-13   0.21647E-13
31   0.11231E-14   0.21805E-14   0.46064E-14   0.11560E-13   0.21647E-13
32   0.11231E-14   0.21805E-14   0.46064E-14   0.11560E-13   0.21647E-13
33   0.11231E-14   0.21805E-14   0.46064E-14   0.11560E-13   0.21647E-13
34   0.11231E-14   0.21805E-14   0.46064E-14   0.11560E-13   0.21647E-13
35   0.11231E-14   0.21805E-14   0.46064E-14   0.11560E-13   0.21647E-13
36   0.11231E-14   0.21805E-14   0.46064E-14   0.11560E-13   0.21647E-13
37   0.11231E-14   0.21805E-14   0.46064E-14   0.11560E-13   0.21647E-13
38   0.11231E-14   0.21805E-14   0.46064E-14   0.11560E-13   0.21647E-13
39   0.11231E-14   0.21805E-14   0.46064E-14   0.11560E-13   0.21647E-13
40   0.11231E-14   0.21805E-14   0.46064E-14   0.11560E-13   0.21647E-13
41   0.11231E-14   0.21805E-14   0.46064E-14   0.11560E-13   0.21647E-13
42   0.11231E-14   0.21805E-14   0.46064E-14   0.11560E-13   0.21647E-13
43   0.11231E-14   0.21805E-14   0.46064E-14   0.11560E-13   0.21647E-13
44   0.11231E-14   0.21805E-14   0.46064E-14   0.11560E-13   0.21647E-13
45   0.11231E-14   0.21805E-14   0.46064E-14   0.11560E-13   0.21647E-13
```

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PARTICLE SIZE RANGE STATISTICS

CORRECTIONS FOR NONIDEALITIES USING SET NO.  1 OF CORRECTION PARAMETERS

  SIZE      CCF  INLET % OUTLET % CUM. OUTLET % NO-RAP EFF. NO-RAP W  NO-RAP P  COR. EFF.   COR. W     COR. P
2.000E-07  2.123  0.033   0.3401       0.2020      98.9465     9.546   1.0535   98.7922     9.260      1.2078
4.000E-07  1.530  0.253   6.6021       3.5559      97.3328     7.599   2.6672   97.2272     7.517      2.7728
7.000E-07  1.297  0.903  24.6438      13.5328      97.2105     7.505   2.7695   97.0434     7.383      2.9566
1.100E-06  1.188  0.815  16.4690       9.8994      97.9346     8.135   2.0654   97.6037     7.823      2.3963
1.600E-06  1.130  1.520  20.1634      13.2054      98.6441     9.017   1.3559   98.2860     8.526      1.7140
2.500E-06  1.083  3.524  22.6235      18.0300      99.3438    10.539   0.6562   98.9906     9.636      1.0094
3.500E-06  1.059  1.652   5.3871       6.8221      99.6667    11.959   0.3333   99.1853    10.085      0.8147
4.500E-06  1.046  1.652   3.0073       6.8869      99.8139    13.181   0.1861   99.1776    10.065      0.8224
6.000E-06  1.035  1.982   0.6231       6.6415      99.9679    16.864   0.0321   99.3389    10.523      0.6611
8.500E-06  1.024  3.304   0.0580       7.4812      99.9982    22.915   0.0018   99.5533    11.345      0.4467
1.250E-05  1.017  4.846   0.0047       6.0039      99.9999    32.391   0.0001   99.7556    12.610      0.2444
2.000E-05  1.010 12.115   0.0119       4.8843      99.9999    50.492   0.0001   99.9205    14.963      0.0795
2.750E-05  1.008 67.401   0.0660       2.8545      99.9999    68.574   0.0001   99.9916    19.688      0.0084

EFFICIENCIES FOR CONVERGENCE CHECK:  STATED OR PREVIOUS CALCULATION =  99.600   FINAL CALCULATION =  99.578


   ADJUSTED NO-RAP EFF. =  99.8978
   MMD OF INLET SIZE DISTRIBUTION =  4.465E+01
   SIGMAP OF INLET SIZE DISTRIBUTION =  5.122E+00
   LOG-NORMAL GOODNESS OF FIT =  0.984
   MMD OF EFFLUENT UNDER NO-RAP CONDITIONS =  1.345E+00
   SIGMAP OF EFFLUENT UNDER NO-RAP CONDITIONS =  1.824E+00
   LOG-NORMAL GOODNESS OF FIT =  0.996
   PRECIPITATION RATE PARAMETER UNDER NO-RAP CONDITIONS = 14.438


   SIGMAG=    0.000  WITH  0.000 SNEAKAGE OVER    4.000  STAGES
   NTEMP = 1
   RMMD =  6.00
   RSIGMA = 2.50
   CORR. EFF. =  99.8027
   CORRECTED MMD OF EFFLUENT =  3.012E+00
   CORRECTED SIGMAP OF EFFLUENT =  2.741E+00
   LOG-NORMAL GOODNESS OF FIT =  0.984
   CORRECTED PRECIPITATION RATE PARAMETER =   13.06
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UNADJUSTED MIGRATION VELOCITIES AND EFFICIENCIES, AND DISCRETE OUTLET MASS LOADINGS

IDEAL UNADJUSTED   IDEAL UNADJUSTED    NO-RAP      RAPPING PUFF   NO-RAP+RAP PUFF   RAPPING PUFF   PARTICLE
   MIG. VEL.          EFFICIENCY      DM/DLOGD      DM/DLOGD        DM/DLOGD       DISTRIBUTION     DIAM.
   (CM/SEC)              (%)         (MG/DSCM)     (MG/DSCM)       (MG/DSCM)           (%)           (M)
   3.929E+00          8.464E+01      5.177E-02     7.580E-03       5.935E-02        5.350E-02     2.000E-07
   3.601E+00          8.205E+01      2.161E+00     8.551E-02       2.247E+00        2.806E-01     4.000E-07
   4.057E+00          8.555E+01      7.011E+00     4.201E-01       7.431E+00        1.586E+00     7.000E-07
   4.936E+00          9.050E+01      7.489E+00     1.200E+00       8.689E+00        2.834E+00     1.100E-06
   6.118E+00          9.459E+01      8.884E+00     2.346E+00       1.123E+01        5.720E+00     1.600E-06
   8.298E+00          9.609E+01      7.727E+00     4.159E+00       1.189E+01        1.308E+01     2.500E-06
   1.073E+01          9.940E+01      3.924E+00     5.667E+00       9.591E+00        8.358E+00     3.500E-06
   1.318E+01          9.981E+01      1.874E+00     6.411E+00       8.285E+00        1.105E+01     4.500E-06
   1.686E+01          9.997E+01      3.447E-01     6.746E+00       7.091E+00        1.310E+01     6.000E-06
   2.291E+01          1.000E+02      2.543E-02     6.312E+00       6.337E+00        1.545E+01     6.500E-06
   3.239E+01          1.000E+02      2.042E-03     4.983E+00       4.985E+00        1.245E+01     1.250E-05
   5.049E+01          1.000E+02      3.806E-03     3.023E+00       3.027E+00        1.013E+01     2.000E-05
   6.857E+01          1.000E+02      6.310E-02     5.265E+00       5.328E+00        5.918E+00     2.750E-05
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                          E.P.A. ESP MODEL
                      I.E.R.L.-R.T.P. AND SO.R.I.

                   SUMMARY TABLE OF ESP OPERATING
                     PARAMETERS AND PERFORMANCE


                          DATA SET NUMBER   1

                   NON-IDEAL CONDITION SET NUMBER  1

ESP PERFORMANCE:     EFFICIENCY =  99.8027 %     SCA =  4.769E+01 M**2/(M**3/SEC)
                                                     ( 242. FT**2/1000 ACFM)

ELECTRICAL CONDITIONS:     AVG. APPLIED VOLTAGE =  4.170E+04 V
                           AVG. CURRENT DENSITY =   20.01 NA/CM**2
                           RESISTIVITY =  5.000E+10 OHM-CM

SIZE DISTRIBUTIONS:     INLET MMD =  4.465E+01 UM     INLET SIGMAP =  5.122E+00
                        OUTLET MMD =  3.012E+00 UM     OUTLET SIGMAP =  2.741E+00

NONIDEAL PARAMETERS:     GAS SNEAKAGE FRACTION =  .00 /SECTION     GAS VELOCITY SIGMAG =  .00
                         RAPPING MMD =  6.000E+00 UM     RAPPING SIGMAP =  2.500E+00
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                              E.P.A. ESP MODEL
                         I.E.R.L.-R.T.P. AND SO.R.I.

                       SUMMARY TABLE OF ESP OPERATING
                         PARAMETERS AND PERFORMANCE


                              DATA SET NUMBER   1

                       NON-IDEAL CONDITION SET NUMBER  2

ESP PERFORMANCE:     EFFICIENCY =  99.4905 %     SCA =  4.769E+01 M**2/(M**3/SEC)
                                                         ( 242. FT**2/1000 ACFM)

ELECTRICAL CONDITIONS:     AVG. APPLIED VOLTAGE =  4.170E+04 V

                           AVG. CURRENT DENSITY =   20.01 NA/CM**2

                           RESISTIVITY =  5.000E+10 OHM-CM

SIZE DISTRIBUTIONS:     INLET MMD =  4.465E+01 UM     INLET SIGMAP =  5.122E+00

                        OUTLET MMD =  3.038E+00 UM     OUTLET SIGMAP =  2.567E+00

NONIDEAL PARAMETERS:     GAS SNEAKAGE FRACTION =  .10 /SECTION     GAS VELOCITY SIGMAG =  .25

                         RAPPING MMD =  6.000E+00 UM     RAPPING SIGMAP =  2.500E+00
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*                                                                                                              *
*                                                                                                              *
*                                            E.P.A. ESP MODEL                                                  *
*                                      I.E.R.L.-R.T.P. AND SO.R.I.                                             *
*                                                                                                              *
*                                     SUMMARY TABLE OF ESP OPERATING                                           *
*                                       PARAMETERS AND PERFORMANCE                                             *
*                                                                                                              *
*                                                                                                              *
*                                                                                                              *
*                                                                                                              *
*                                            DATA SET NUMBER   1                                               *
*                                                                                                              *
*                                     NON-IDEAL CONDITION SET NUMBER  3                                        *
*                                                                                                              *
*                                                                                                              *
*           ESP PERFORMANCE:    EFFICIENCY =  98.4130 %    SCA =  4.769E+01 M**2/(M**3/SEC)                    *
*                                                                                                              *
*                                                                   ( 242. FT**2/1000 ACFM)                    *
*                                                                                                              *
*                                                                                                              *
*           ELECTRICAL CONDITIONS:    AVG. APPLIED VOLTAGE =  4.170E+04 V                                      *
*                                                                                                              *
*                                     AVG. CURRENT DENSITY =   20.01 NA/CM**2                                  *
*                                                                                                              *
*                                     RESISTIVITY =  5.000E+10 OHM-CM                                          *
*                                                                                                              *
*                                                                                                              *
*           SIZE DISTRIBUTIONS:    INLET MMD =  4.465E+01 UM    INLET SIGMAP =  5.122E+00                      *
*                                                                                                              *
*                                  OUTLET MMD =  3.715E+00 UM    OUTLET SIGMAP =  2.579E+00                    *
*                                                                                                              *
*                                                                                                              *
*           NONIDEAL PARAMETERS:    GAS SNEAKAGE FRACTION =  .30 /SECTION    GAS VELOCITY SIGMAG =  .25        *
*                                                                                                              *
*                                   RAPPING MMD =  6.000E+00 UM    RAPPING SIGMAP =  2.500E+00                 *
*                                                                                                              *
*                                                                                                              *
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*                                                                                         *
*                                    E.P.A. ESP MODEL                                     *
*                               I.E.R.L.-R.T.P. AND SO.R.I.                               *
*                                                                                         *
*                             SUMMARY TABLE OF ESP OPERATING                              *
*                               PARAMETERS AND PERFORMANCE                                *
*                                                                                         *
*                                                                                         *
*                                   DATA SET NUMBER   1                                   *
*                                                                                         *
*                             NON-IDEAL CONDITION SET NUMBER  4                           *
*                                                                                         *
*   ESP PERFORMANCE:     EFFICIENCY =  95.0599 %     SCA =  4.769E+01 M**2/(M**3/SEC)     *
*                                                           ( 242. FT**2/1000 ACFM)       *
*                                                                                         *
*   ELECTRICAL CONDITIONS:     AVG. APPLIED VOLTAGE =  4.170E+04 V                        *
*                                                                                         *
*                              AVG. CURRENT DENSITY =   20.01 NA/CM**2                    *
*                                                                                         *
*                              RESISTIVITY =  5.000E+10 OHM-CM                            *
*                                                                                         *
*   SIZE DISTRIBUTIONS:      INLET MMD =  4.465E+01 UM     INLET SIGMAP =  5.122E+00      *
*                                                                                         *
*                            OUTLET MMD =  5.965E+00 UM     OUTLET SIGMAP =  3.013E+00    *
*                                                                                         *
*   NONIDEAL PARAMETERS:     GAS SNEAKAGE FRACTION =  .50 /SECTION     GAS VELOCITY SIGMAG =  .25
*                                                                                         *
*                            RAPPING MMD =  6.000E+00 UM     RAPPING SIGMAP =  2.500E+00  *
*                                                                                         *
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                                 E.P.A. ESP MODEL
                              I.E.R.L.-R.T.P. AND SO.R.I.

                            SUMMARY TABLE OF ESP OPERATING
                              PARAMETERS AND PERFORMANCE


                                  DATA SET NUMBER   1

                            NON-IDEAL CONDITION SET NUMBER  5

     ESP PERFORMANCE:     EFFICIENCY =  83.5233 %     SCA =  4.769E+01 M**2/(M**3/SEC)
                                                             ( 242. FT**2/1000 ACFM)

     ELECTRICAL CONDITIONS:     AVG. APPLIED VOLTAGE =  4.170E+04 V
                                AVG. CURRENT DENSITY =   20.01 NA/CM**2
                                RESISTIVITY =  5.000E+10 OHM-CM

     SIZE DISTRIBUTIONS:     INLET MMD =  4.465E+01 UM     INLET SIGMAP =  5.122E+00
                             OUTLET MMD =  1.217E+01 UM     OUTLET SIGMAP =  3.723E+00

     NONIDEAL PARAMETERS:     GAS SNEAKAGE FRACTION =  .70 /SECTION     GAS VELOCITY SIGMAG =  .25
                              RAPPING MMD =  6.000E+00 UM     RAPPING SIGMAP =  2.500E+00

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                              E.P.A. ESP MODEL
                         I.E.R.L.-R.T.P. AND SO.R.I.

                        SUMMARY TABLE OF ESP OPERATING
                          PARAMETERS AND PERFORMANCE


                              DATA SET NUMBER   1

                         NON-IDEAL CONDITION SET NUMBER  6

ESP PERFORMANCE:     EFFICIENCY =  99.6130 %     SCA =  4.769E+01 M**2/(M**3/SEC)
                                                      ( 242. FT**2/1000 ACFM)

ELECTRICAL CONDITIONS:     AVG. APPLIED VOLTAGE =  4.170E+04 V

                           AVG. CURRENT DENSITY =   20.01 NA/CM**2

                           RESISTIVITY =  5.000E+10 OHM-CM

SIZE DISTRIBUTIONS:     INLET MMD =  4.465E+01 UM     INLET SIGMAP =  5.122E+00

                        OUTLET MMD =  2.966E+00 UM     OUTLET SIGMAP =  2.614E+00

NONIDEAL PARAMETERS:     GAS SNEAKAGE FRACTION =  .10 /SECTION     GAS VELOCITY SIGMAG =  .10

                         RAPPING MMD =  6.000E+00 UM     RAPPING SIGMAP =  2.500E+00
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                              E.P.A. ESP MODEL
                         I.E.R.L.-R.T.P. AND SO.R.I.

                        SUMMARY TABLE OF ESP OPERATING
                          PARAMETERS AND PERFORMANCE


                              DATA SET NUMBER   1

                        NON-IDEAL CONDITION SET NUMBER  7

ESP PERFORMANCE:     EFFICIENCY =  99.2944 %     SCA =  4,769E+01 M**2/(M**3/SEC)
                                                          ( 242. FT**2/1000 ACFM)

ELECTRICAL CONDITIONS:     AVG. APPLIED VOLTAGE =  4,170E+04 V
                           AVG. CURRENT DENSITY =   20,01 NA/CM**2
                           RESISTIVITY =  5,000E+10 OHM-CM

SIZE DISTRIBUTIONS:     INLET MMD =  4.465E+01 UM     INLET SIGMAP =  5,122E+00
                        OUTLET MMD =  3,110E+00 UM     OUTLET SIGMAP =  2,526E+00

NONIDEAL PARAMETERS:     GAS SNEAKAGE FRACTION =  .10 /SECTION     GAS VELOCITY SIGMAG =  .40
                         RAPPING MMD =  6,000E+00 UM     RAPPING SIGMAP =  2,500E+00
                        E.P.A. ESP MODEL
                   I.E.R.L.-R.T.P. AND SO.R.I.

                 SUMMARY TABLE OF ESP OPERATING
                   PARAMETERS AND PERFORMANCE


                        DATA SET NUMBER   1

                 NON-IDEAL CONDITION SET NUMBER  8

ESP PERFORMANCE:     EFFICIENCY =  98.6896 %     SCA =  4.769E+01 M**2/(M**3/SEC)
                                                     ( 242. FT**2/1000 ACFM)

ELECTRICAL CONDITIONS:     AVG. APPLIED VOLTAGE =  4.170E+04 V
                           AVG. CURRENT DENSITY =   20.01 NA/CM**2
                           RESISTIVITY =  5.000E+10 OHM-CM

SIZE DISTRIBUTIONS:     INLET MMD =  4.465E+01 UM     INLET SIGMAP =  5.122E+00
                        OUTLET MMD =  3.273E+00 UM     OUTLET SIGMAP =  2.507E+00

NONIDEAL PARAMETERS:     GAS SNEAKAGE FRACTION =  .10 /SECTION     GAS VELOCITY SIGMAG =  .60
                         RAPPING MMD =  6.000E+00 UM     RAPPING SIGMAP =  2.500E+00
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*                                                                                                *
*                                      E.P.A. ESP MODEL                                          *
*                                 I.E.R.L.-R.T.P. AND SO.R.I.                                    *
*                                                                                                *
*                                 SUMMARY TABLE OF ESP OPERATING                                 *
*                                   PARAMETERS AND PERFORMANCE                                   *
*                                                                                                *
*                                                                                                *
*                                      DATA SET NUMBER   1                                       *
*                                                                                                *
*                                 NON-IDEAL CONDITION SET NUMBER  9                              *
*                                                                                                *
*           ESP PERFORMANCE:     EFFICIENCY =  98.2909 %     SCA =  4.769E+01 M**2/(M**3/SEC)    *
*                                                                ( 242. F1**2/1000 ACFM)         *
*                                                                                                *
*           ELECTRICAL CONDITIONS:     AVG. APPLIED VOLTAGE =  4.170E+04 V                       *
*                                      AVG. CURRENT DENSITY =   20.01 NA/CM**2                   *
*                                      RESISTIVITY =  5.000E+10 OHM-CM                           *
*                                                                                                *
*           SIZE DISTRIBUTIONS:     INLET MMD =  4.465E+01 UM     INLET SIGMAP =  5.122E+00      *
*                                   OUTLET MMD =  3.533E+00 UM     OUTLET SIGMAP =  2.541E+00    *
*                                                                                                *
*           NONIDEAL PARAMETERS:     GAS SNEAKAGE FRACTION =  .10 /SECTION     GAS VELOCITY SIGMAG =  .80  *
*                                    RAPPING MMD =  6.000E+00 UM     RAPPING SIGMAP =  2.500E+00 *
*                                                                                                *
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                              E.P.A. ESP MODEL
                        I.E.R.L.-R.T.P. AND SO.R.I.

                      SUMMARY TABLE OF ESP OPERATING
                        PARAMETERS AND PERFORMANCE


                            DATA SET NUMBER   1

                      NON-IDEAL CONDITION SET NUMBER 11

ESP PERFORMANCE:     EFFICIENCY =  99.4905 %     SCA =  4.769E+01 M**2/(M**3/SEC)
                                                        ( 242. FT**2/1000 ACFM)

ELECTRICAL CONDITIONS:     AVG. APPLIED VOLTAGE =  4.170E+04 V

                           AVG. CURRENT DENSITY =   20.01 NA/CM**2

                           RESISTIVITY =  5.000E+10 OHM-CM

SIZE DISTRIBUTIONS:     INLET MMD =  4.465E+01 UM     INLET SIGMAP =  5.122E+00

                        OUTLET MMD =  1.933E+00 UM     OUTLET SIGMAP =  2.254E+00

NONIDEAL PARAMETERS:     GAS SNEAKAGE FRACTION =  .10 /SECTION     GAS VELOCITY SIGMAG =  .25

                         RAPPING MMD =  2.000E+00 UM     RAPPING SIGMAP =  2.500E+00
```

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*******************************************************************************************************
*                                                                                                     *
*                                         E.P.A. ESP MODEL                                            *
*                                    I.E.R.L.-R.T.P. AND SO.R.I.                                      *
*                                                                                                     *
*                                   SUMMARY TABLE OF ESP OPERATING                                    *
*                                     PARAMETERS AND PERFORMANCE                                      *
*                                                                                                     *
*                                                                                                     *
*                                         DATA SET NUMBER   1                                         *
*                                                                                                     *
*                                   NON-IDEAL CONDITION SET NUMBER 20                                 *
*                                                                                                     *
*         ESP PERFORMANCE:     EFFICIENCY =  99.4905 %     SCA =  4.769E+01 M**2/(M**3/SEC)           *
*                                                                                                     *
*                                                             ( 242. FT**2/1000 ACFM)                 *
*                                                                                                     *
*         ELECTRICAL CONDITIONS:     AVG. APPLIED VOLTAGE =  4.170E+04 V                              *
*                                                                                                     *
*                                    AVG. CURRENT DENSITY =   20.01 NA/CM**2                          *
*                                                                                                     *
*                                    RESISTIVITY =  5.000E+10 OHM-CM                                  *
*                                                                                                     *
*         SIZE DISTRIBUTIONS:     INLET MMD =  4.465E+01 UM     INLET SIGMAP =  5.122E+00             *
*                                                                                                     *
*                                 OUTLET MMD =  3.652E+00 UM     OUTLET SIGMAP =  2.848E+00           *
*                                                                                                     *
*         NONIDEAL PARAMETERS:     GAS SNEAKAGE FRACTION =  .10 /SECTION     GAS VELOCITY SIGMAG =  .25
*                                                                                                     *
*                                  RAPPING MMD =  1.000E+01 UM     RAPPING SIGMAP =  2.500E+00        *
*                                                                                                     *
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*                                                                                         *
*                                   E.P.A. ESP MODEL                                      *
*                            I.E.R.L.-R.T.P. AND SO.R.I.                                  *
*                                                                                         *
*                            SUMMARY TABLE OF ESP OPERATING                               *
*                              PARAMETERS AND PERFORMANCE                                 *
*                                                                                         *
*                                                                                         *
*                                 DATA SET NUMBER   1                                     *
*                                                                                         *
*                           NON-IDEAL CONDITION SET NUMBER 29                             *
*                                                                                         *
*          ESP PERFORMANCE:     EFFICIENCY =  99.4905 %     SCA =  4.769E+01 M**2/(M**3/SEC)   *
*                                                          ( 242. FT**2/1000 ACFM)       *
*                                                                                         *
*          ELECTRICAL CONDITIONS:     AVG. APPLIED VOLTAGE =  4.170E+04 V                 *
*                                     AVG. CURRENT DENSITY =   20.01 NA/CM**2             *
*                                     RESISTIVITY =  5.000E+10 OHM-CM                     *
*                                                                                         *
*          SIZE DISTRIBUTIONS:     INLET MMD =  4.465E+01 UM     INLET SIGMAP =  5.122E+00     *
*                                  OUTLET MMD =  4.170E+00 UM     OUTLET SIGMAP =  3.112E+00   *
*                                                                                         *
*          NONIDEAL PARAMETERS:     GAS SNEAKAGE FRACTION =  .10 /SECTION     GAS VELOCITY SIGMAG =  .25   *
*                                   RAPPING MMD =  1.500E+01 UM     RAPPING SIGMAP =  2.500E+00   *
*                                                                                         *
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                              E.P.A. ESP MODEL
                         I.E.R.L.-R.T.P. AND SO.R.I.

                       SUMMARY TABLE OF ESP OPERATING
                         PARAMETERS AND PERFORMANCE


                              DATA SET NUMBER   1

                       NON-IDEAL CONDITION SET NUMBER 38

ESP PERFORMANCE:     EFFICIENCY =  99.4905 %     SCA =  4.769E+01 M**2/(M**3/SEC)
                                                        ( 242. FT**2/1000 ACFM)

ELECTRICAL CONDITIONS:     AVG. APPLIED VOLTAGE =  4.170E+04 V
                           AVG. CURRENT DENSITY =   20.01 NA/CM**2
                           RESISTIVITY =  5.000E+10 OHM-CM

SIZE DISTRIBUTIONS:     INLET MMD =  4.465E+01 UM     INLET SIGMAP =  5.172E+00
                        OUTLET MMD =  4.532E+00 UM     OUTLET SIGMAP =  3.305E+00

NONIDEAL PARAMETERS:     GAS SNEAKAGE FRACTION =  .10 /SECTION     GAS VELOCITY SIGMAG =  .25
                         RAPPING MMD =  2.000E+01 UM     RAPPING SIGMAP =  2.500E+00

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*                                                                                 *
*                           E.P.A. ESP MODEL                                      *
*                     I.E.R.L.-R.T.P. AND SO.R.I.                                 *
*                                                                                 *
*                      SUMMARY TABLE OF ESP OPERATING                             *
*                        PARAMETERS AND PERFORMANCE                               *
*                                                                                 *
*                                                                                 *
*                            DATA SET NUMBER   1                                  *
*                                                                                 *
*                     NON-IDEAL CONDITION SET NUMBER 47                           *
*                                                                                 *
*   ESP PERFORMANCE:     EFFICIENCY =  99.4905 %     SCA =  4.769E+01 M**2/(M**3/SEC)  *
*                                                        ( 242. FT**2/1000 ACFM)  *
*                                                                                 *
*   ELECTRICAL CONDITIONS:     AVG. APPLIED VOLTAGE =  4,170E+04 V                *
*                              AVG. CURRENT DENSITY =   20,01 NA/CM**2            *
*                              RESISTIVITY =  5,000E+10 OHM-CM                    *
*                                                                                 *
*   SIZE DISTRIBUTIONS:     INLET MMD =  4,465E+01 UM     INLET SIGMAP =  5,122E+00  *
*                           OUTLET MMD =  3,559E+00 UM     OUTLET SIGMAP =  2,673E+00  *
*                                                                                 *
*   NONIDEAL PARAMETERS:     GAS SNEAKAGE FRACTION =  .10 /SECTION     GAS VELOCITY SIGMAG =  .25  *
*                            RAPPING MMD =  1,000E+01 UM     RAPPING SIGMAP =  1,500E+00  *
*                                                                                 *
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                               E.P.A. ESP MODEL
                            I.E.R.L.-R.T.P. AND SO.R.I.

                          SUMMARY TABLE OF ESP OPERATING
                           PARAMETERS AND PERFORMANCE


                               DATA SET NUMBER   1

                        NON-IDEAL CONDITION SET NUMBER 56

    ESP PERFORMANCE:     EFFICIENCY =  99.4905 %     SCA =  4.769E+01 M**2/(M**3/SEC)
                                                          ( 242. FT**2/1000 ACFM)

    ELECTRICAL CONDITIONS:     AVG. APPLIED VOLTAGE =  4.170E+04 V
                               AVG. CURRENT DENSITY =   20.01 NA/CM**2
                               RESISTIVITY =  5.000E+10 OHM-CM

    SIZE DISTRIBUTIONS:     INLET MMD =  4.465E+01 UM     INLET SIGMAP =  5.122E+00
                            OUTLET MMD =  3.441E+00 UM     OUTLET SIGMAP =  3.254E+00

    NONIDEAL PARAMETERS:     GAS SNEAKAGE FRACTION =  .10 /SECTION     GAS VELOCITY SIGMAG =  .25
                             RAPPING MMD =  1.000E+01 UM     RAPPING SIGMAP =  5.000E+00
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********************************************************************************************
*                                                                                          *
*                                     E.P.A. ESP MODEL                                     *
*                              I.E.R.L.-R.T.P. AND SO.R.I.                                 *
*                                                                                          *
*                              SUMMARY TABLE OF ESP OPERATING                              *
*                                PARAMETERS AND PERFORMANCE                                *
*                                                                                          *
*                                                                                          *
*                                     DATA SET NUMBER   1                                  *
*                                                                                          *
*                              NON-IDEAL CONDITION SET NUMBER 65                           *
*                                                                                          *
*     ESP PERFORMANCE:     EFFICIENCY =  99.4905 %     SCA =  4.769E+01 M**2/(M**3/SEC)     *
*                                                            ( 242. FT**2/1000 ACFM)       *
*                                                                                          *
*     ELECTRICAL CONDITIONS:     AVG. APPLIED VOLTAGE =  4.170E+04 V                        *
*                                AVG. CURRENT DENSITY =   20.01 NA/CM**2                   *
*                                RESISTIVITY =  5.000E+10 OHM-CM                           *
*                                                                                          *
*     SIZE DISTRIBUTIONS:     INLET MMD =  4.465E+01 UM     INLET SIGMAP =  5.122E+00       *
*                             OUTLET MMD =  3.222E+00 UM     OUTLET SIGMAP =  3.701E+00     *
*                                                                                          *
*     NONIDEAL PARAMETERS:     GAS SNEAKAGE FRACTION =  .10 /SECTION     GAS VELOCITY SIGMAG =  .25
*                              RAPPING MMD =  1.000E+01 UM     RAPPING SIGMAP =  1.000E+01  *
*                                                                                          *
********************************************************************************************
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****************************************************************************************************
*                                                                                                  *
*                                      E.P.A. ESP MODEL                                            *
*                                 I.E.R.L.-R.T.P. AND SO.R.I.                                      *
*                                                                                                  *
*                                SUMMARY TABLE OF ESP OPERATING                                    *
*                                  PARAMETERS AND PERFORMANCE                                      *
*                                                                                                  *
*                                                                                                  *
*                                      DATA SET NUMBER   1                                         *
*                                                                                                  *
*                                NON-IDEAL CONDITION SET NUMBER 74                                 *
*                                                                                                  *
*        ESP PERFORMANCE:     EFFICIENCY =  99.4905 %     SCA =  4,769E+01 M**2/(M**3/SEC)         *
*                                                              ( 242. FT**2/1000 ACFM)             *
*                                                                                                  *
*        ELECTRICAL CONDITIONS:     AVG. APPLIED VOLTAGE =  4,170E+04 V                            *
*                                   AVG. CURRENT DENSITY =   20,01 NA/CM**2                        *
*                                   RESISTIVITY =  5,000E+10 OHM-CM                                *
*                                                                                                  *
*        SIZE DISTRIBUTIONS:      INLET MMD =  4,465E+01 UM     INLET SIGMAP =  5,122E+00          *
*                                 OUTLET MMD =  3,168E+00 UM     OUTLET SIGMAP =  3,888E+00        *
*                                                                                                  *
*        NONIDEAL PARAMETERS:     GAS SNEAKAGE FRACTION =  .10 /SECTION     GAS VELOCITY SIGMAG =  .25  *
*                                 RAPPING MMD =  1,000E+01 UM     RAPPING SIGMAP =  1,500E+01      *
*                                                                                                  *
****************************************************************************************************
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APPENDIX K

OUTPUT DATA FROM EXAMPLE 12

```
                    ***********************************
                    *                                 *
                    *         E.P.A. ESP MODEL        *
                    *                                 *
                    *   I.E.R.L.-R.T.P. AND SO.R.I.   *
                    *                                 *
                    *           REVISION III          *
                    *                                 *
                    ***********************************

PRINTOUT OF INPUT DATA FOR DATA SET NUMBER  1


DATA ON CARD NUMBER   1

NENDPT = 15   NDATA =  1   NRAP =  0   MODL =  0   NOPRNT =  0   PATHL =  0.00 FT   NCOMPS =  0   NWAVES =  0  NLAMDA =  0

DATA ON CARD NUMBER   2

FULL-SCALE,HOT-SIDE ESP: PLANT B;SCA=390FT2/1000ACFM;J=34.30A/FT2;EST. PROCED.

DATA ON CARD NUMBER   3

NEST =  2  NDIST =  1  NVI =  1  NX = 10  NY = 10  NITER =  3  NCALC =  1  NRAPD =  1  NEFF =  1  NTEMP =  2  NONID =  2

DATA ON CARD NUMBER   4

DL =  2.51000 GRN/ACF  PL =  36.0000 FT  ETAO = 99.60000 %  DD =  2270.00 KG/M**3  EPS =  1.000E+02
VRATIO =   1.2000  US =  .000220 M**2/V-SEC  FPATH =   1.0000  EBD = 1500000. V/M  RHOCGS =  1.90E+10 OHM-CM

DATA ON CARD NUMBER   5

ASNUCK( 1) =  .00  AZIGGY( 1) =  .00  AZNUMS( 1) =  4.0
ASNUCK( 2) =  .10  AZIGGY( 2) =  .25  AZNUMS( 2) =  4.0


DATA ON CARD NUMBER   6

ENDPT( 1) =    0.200 UM   ENDPT( 2) =    0.400 UM   ENDPT( 3) =    0.700 UM   ENDPT( 4) =    1.000 UM   ENDPT( 5) =    1.500 UM
ENDPT( 6) =    2.000 UM   ENDPT( 7) =    3.000 UM   ENDPT( 8) =    4.000 UM   ENDPT( 9) =    5.000 UM   ENDPT(10) =    7.000 UM
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DATA ON CARD NUMBER   7

ENDPT(11) =   10.000 UM   ENDPT(12) =   15.000 UM   ENDPT(13) =   25.000 UM   ENDPT(14) =   30.000 UM   ENDPT(15) =  100.000 UM


DATA ON CARD NUMBER   8

PRCU( 1) =   0.0000 %   PRCU( 2) =   0.1479 %   PRCU( 3) =   0.5742 %   PRCU( 4) =   1.0092 %   PRCU( 5) =   1.7226 %
PRCU( 6) =   2.7493 %   PRCU( 7) =   6.5251 %   PRCU( 8) =   9.4832 %   PRCU( 9) =  11.1363 %   PRCU(10) =  13.0503 %


DATA ON CARD NUMBER   9

PRCU(11) =  15.6256 %   PRCU(12) =  20.1844 %   PRCU(13) =  30.9727 %   PRCU(14) =  35.4968 %   PRCU(15) = 100.0000 %


DATA ON CARD NUMBER  10

NUMSEC =  4    LSECT( 1) =  9  LSECT( 2) =  9  LSECT( 3) =  9  LSECT( 4) =  9

DATA ON CARD NUMBER  11

AS( 1) =  4.2120E+04 FT**2  VOS( 1) =  3.5880E+04 V  TCS( 1) =  1.2200E+00 A  WLS( 1) =  5.6160E+04 FT
ACS( 1) =  5.4500E-02 IN  BS( 1) =  4.5000E+00 IN  NWS( 1) =  1.2000E+01

DATA ON CARD NUMBER  12

SYS( 1) =  4.5000E+00 IN  VGS( 1) =  4.3207E+05 FT**3/MIN  VGASS( 1) =  3.7958E+00 FT/SEC  TEMPS( 1) =  6.2400E+02 F
PS( 1) =  1.0000E+00 ATM  VISS( 1) =  2.8000E-05 KG/M-SEC  LINCS( 1) =  1.0000E+00 FT

DATA ON CARD NUMBER  13

AS( 2) =  4.2120E+04 FT**2  VOS( 2) =  3.3950E+04 V  TCS( 2) =  1.6720E+00 A  WLS( 2) =  5.6160E+04 FT
ACS( 2) =  5.4500E-02 IN  BS( 2) =  4.5000E+00 IN  NWS( 2) =  1.2000E+01

DATA ON CARD NUMBER  14

SYS( 2) =  4.5000E+00 IN  VGS( 2) =  4.3207E+05 FT**3/MIN  VGASS( 2) =  3.7958E+00 FT/SEC  TEMPS( 2) =  6.2400E+02 F
PS( 2) =  1.0000E+00 ATM  VISS( 2) =  2.8000E-05 KG/M-SEC  LINCS( 2) =  1.0000E+00 FT
```

```
DATA ON CARD NUMBER  15

AS( 3) =  4.2120E+04 FT**2  VOS( 3) =  2.9130E+04 V  TCS( 3) =  1.4200E+00 A  WLS( 3) =  5.6160E+04 FT
ACS( 3) =  5.4500E-02 IN  BS( 3) =  4.5000E+00 IN  NWS( 3) =  1.2000E+01

DATA ON CARD NUMBER  16

SYS( 3) =  4.5000E+00 IN  VGS( 3) =  4.3207E+05 FT**3/MIN  VGASS( 3) =  3.7958E+00 FT/SEC  TEMPS( 3) =  6.2400E+02 F
PS( 3) =  1.0000E+00 ATM  VISS( 3) =  2.8000E-05 KG/M-SEC  LINCS( 3) =  1.0000E+00 FT

DATA ON CARD NUMBER  17

AS( 4) =  4.2120E+04 FT**2  VOS( 4) =  2.7500E+04 V  TCS( 4) =  1.4600E+00 A  WLS( 4) =  5.6160E+04 FT
ACS( 4) =  5.4500E-02 IN  BS( 4) =  4.5000E+00 IN  NWS( 4) =  1.2000E+01

DATA ON CARD NUMBER  18

SYS( 4) =  4.5000E+00 IN  VGS( 4) =  4.3207E+05 FT**3/MIN  VGASS( 4) =  3.7958E+00 FT/SEC  TEMPS( 4) =  6.2400E+02 F
PS( 4) =  1.0000E+00 ATM  VISS( 4) =  2.8000E-05 KG/M-SEC  LINCS( 4) =  1.0000E+00 FT
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INCREMENTAL ANALYSIS OF PRECIPITATOR PERFORMANCE


FULL-SCALE,HOT-SIDE ESP: PLANT B;SCA=390FT2/1000ACFM;J=34.30A/FT2;EST. PROCED.

CALCULATION IS IN SECTION NO. = 1 AND THE SECTION LENGTH IS =  2.7450 M

COLLECTION AREA =  3.917E+03 M2           APPLIED VOLTAGE =  3.588E+04 VOLTS          TOTAL CURRENT =  1.220E+00 AMPS
WIRE TO PLATE =  1.143E-01 M              CORONA WIRE RADIUS =  1.384E-03 M           CORONA WIRE LENGTH =  1.713E+04 M
CURRENT/M =  7.123E-05 AMP/M              CURRENT DENSITY =  3.115E-04 AMP/M2         DEPOSIT E FIELD =  5.918E+04 VOLT/M
1/2 WIRE TO WIRE =  1.143E-01 M           GAS FLOW RATE =  2.044E+02 M3/SEC           GAS VELOCITY =  1.158E+00 M/SEC
TEMPERATURE = 601.667 K                   PRESSURE =   1.000 ATM                      VISCOSITY =  2.800E-05 KG/M-SEC
ION MOBILITY =  4.846E-04 M2/VOLT-SEC     MEAN THERMAL SPEED =  6.311E+02 M/SEC       PART. PATH PARAM. =  1.154E-07 M
DUST WEIGHT =  1.175E+00 KG/SEC           LENGTH INCR. = .30500000 M                  INPUT EFF./INCR. = 14.22

ROVRI    ERAVG       EPLT        AFID        CMCD     MMD        WEIGHT      DUST LAYER   J(PART)     J(ION)     INCR. NO.

1.5597   3.139E+05   1.7938E+05  8.2047E+12   31.1    4.21E-05   4.140E-03   1.166E-01    1.35E-06    3.10E-04       1
1.3610   3.139E+05   1.7938E+05  9.4026E+12   31.1    2.00E-05   7.275E-04   2.049E-02    8.40E-07    3.11E-04       2
1.2586   3.139E+05   1.7938E+05  1.0167E+13   31.1    1.07E-05   2.597E-04   7.318E-03    6.60E-07    3.11E-04       3
1.1904   3.139E+05   1.7938E+05  1.0750E+13   31.1    6.31E-06   1.473E-04   4.151E-03    5.57E-07    3.11E-04       4
1.1418   3.139E+05   1.7938E+05  1.1207E+13   31.1    4.25E-06   9.762E-05   2.750E-03    4.81E-07    3.11E-04       5
1.1064   3.139E+05   1.7938E+05  1.1566E+13   31.1    3.34E-06   7.003E-05   1.973E-03    4.21E-07    3.11E-04       6
1.0802   3.139E+05   1.7938E+05  1.1847E+13   31.1    2.96E-06   5.295E-05   1.492E-03    3.71E-07    3.11E-04       7
1.0606   3.139E+05   1.7938E+05  1.2065E+13   31.1    2.68E-06   4.146E-05   1.168E-03    3.28E-07    3.11E-04       8
1.0460   3.139E+05   1.7938E+05  1.2234E+13   31.1    2.47E-06   3.324E-05   9.364E-04    2.92E-07    3.11E-04       9

CALCULATION IS IN SECTION NO. = 2 AND THE SECTION LENGTH IS =  2.7450 M

COLLECTION AREA =  3.917E+03 M2           APPLIED VOLTAGE =  3.395E+04 VOLTS          TOTAL CURRENT =  1.672E+00 AMPS
WIRE TO PLATE =  1.143E-01 M              CORONA WIRE RADIUS =  1.384E-03 M           CORONA WIRE LENGTH =  1.713E+04 M
CURRENT/M =  9.761E-05 AMP/M              CURRENT DENSITY =  4.268E-04 AMP/M2         DEPOSIT E FIELD =  8.110E+04 VOLT/M
1/2 WIRE TO WIRE =  1.143E-01 M           GAS FLOW RATE =  2.044E+02 M3/SEC           GAS VELOCITY =  1.158E+00 M/SEC
TEMPERATURE = 601.667 K                   PRESSURE =   1.000 ATM                      VISCOSITY =  2.800E-05 KG/M-SEC
ION MOBILITY =  4.846E-04 M2/VOLT-SEC     MEAN THERMAL SPEED =  6.311E+02 M/SEC       PART. PATH PARAM. =  1.154E-07 M
DUST WEIGHT =  1.175E+00 KG/SEC           LENGTH INCR. = .30500000 M                  INPUT EFF./INCR. = 14.22

ROVRI    ERAVG       EPLT        AFID        CMCD     MMD        WEIGHT      DUST LAYER   J(PART)     J(ION)     INCR. NO.

1.0241   2.970E+05   1.6973E+05  1.8098E+13   42.7    2.38E-06   2.577E-05   7.259E-04    2.47E-07    4.27E-04      10
1.0185   2.970E+05   1.6973E+05  1.8198E+13   42.7    2.30E-06   2.143E-05   6.037E-04    2.22E-07    4.27E-04      11
1.0142   2.970E+05   1.6973E+05  1.8276E+13   42.7    2.24E-06   1.798E-05   5.065E-04    2.00E-07    4.27E-04      12
1.0109   2.970E+05   1.6973E+05  1.8335E+13   42.7    2.18E-06   1.518E-05   4.277E-04    1.80E-07    4.27E-04      13
1.0084   2.970E+05   1.6973E+05  1.8381E+13   42.7    2.13E-06   1.289E-05   3.632E-04    1.62E-07    4.27E-04      14
1.0065   2.970E+05   1.6973E+05  1.8416E+13   42.7    2.08E-06   1.100E-05   3.098E-04    1.47E-07    4.27E-04      15
1.0050   2.970E+05   1.6973E+05  1.8443E+13   42.7    2.03E-06   9.420E-06   2.654E-04    1.32E-07    4.27E-04      16
1.0038   2.970E+05   1.6973E+05  1.8464E+13   42.7    1.99E-06   8.097E-06   2.281E-04    1.20E-07    4.27E-04      17
1.0030   2.970E+05   1.6973E+05  1.8480E+13   42.7    1.95E-06   6.981E-06   1.967E-04    1.08E-07    4.27E-04      18

CALCULATION IS IN SECTION NO. = 3 AND THE SECTION LENGTH IS =  2.7450 M

COLLECTION AREA =  3.917E+03 M2           APPLIED VOLTAGE =  2.913E+04 VOLTS          TOTAL CURRENT =  1.420E+00 AMPS
WIRE TO PLATE =  1.143E-01 M              CORONA WIRE RADIUS =  1.384E-03 M           CORONA WIRE LENGTH =  1.713E+04 M
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CURRENT/M =  6,290E-05 AMP/M          CURRENT DENSITY =  3,625E-04 AMP/M2     DEPOSIT E FIELD =  6,888E+04 VOLT/M
1/2 WIRE TO WIRE =  1,143E-01 M       GAS FLOW RATE =  2,044E+02 M3/SEC       GAS VELOCITY =  1,158E+00 M/SEC
TEMPERATURE = 601,667 K               PRESSURE =   1,000 ATM                  VISCOSITY =  2,800E-05 KG/M-SEC
ION MOBILITY =  4,846E-04 M2/VOLT-SEC MEAN THERMAL SPEED =  6,311E+02 M/SEC   PART. PATH PARAM. =  1,154E-07 M
DUST WEIGHT =  1,175E+00 KG/SEC       LENGTH INCR. = ,30500000 M              INPUT EFF./INCR. = 14,22


ROVRI     ERAVG       EPLT        AFID        CMCD     MMD       WEIGHT     DUST LAYER   J(PART)      J(ION)   INCR. NO.

1,0023  2,549E+05  1,4563E+05  1,8304E+13   36,3   1,91E-06   5,231E-06   1,474E-04   8,45E-08    3,62E-04     19
1,0018  2,549E+05  1,4563E+05  1,8313E+13   36,3   1,87E-06   4,625E-06   1,303E-04   7,74E-08    3,62E-04     20
1,0014  2,549E+05  1,4563E+05  1,8320E+13   36,3   1,84E-06   4,096E-06   1,154E-04   7,10E-08    3,62E-04     21
1,0011  2,549E+05  1,4563E+05  1,8325E+13   36,3   1,80E-06   3,634E-06   1,024E-04   6,51E-08    3,62E-04     22
1,0009  2,549E+05  1,4563E+05  1,8330E+13   36,3   1,77E-06   3,230E-06   9,099E-05   5,97E-08    3,62E-04     23
1,0007  2,549E+05  1,4563E+05  1,8333E+13   36,3   1,72E-06   2,874E-06   8,097E-05   5,47E-08    3,62E-04     24
1,0005  2,549E+05  1,4563E+05  1,8336E+13   36,3   1,67E-06   2,561E-06   7,216E-05   5,02E-08    3,62E-04     25
1,0004  2,549E+05  1,4563E+05  1,8338E+13   36,3   1,62E-06   2,286E-06   6,440E-05   4,60E-08    3,62E-04     26
1,0003  2,549E+05  1,4563E+05  1,8340E+13   36,3   1,57E-06   2,043E-06   5,754E-05   4,22E-08    3,62E-04     27

CALCULATION IS IN SECTION NO. = 4 AND THE SECTION LENGTH IS =  2,7450 M

COLLECTION AREA =  3,917E+03 M2       APPLIED VOLTAGE =  2,750E+04 VOLTS      TOTAL CURRENT =  1,460E+00 AMPS
WIRE TO PLATE =  1,143E-01 M          CORONA WIRE RADIUS =  1,384E-03 M       CORONA WIRE LENGTH =  1,713E+04 M
CURRENT/M =  6,524E-05 AMP/M          CURRENT DENSITY =  3,727E-04 AMP/M2     DEPOSIT E FIELD =  7,082E+04 VOLT/M
1/2 WIRE TO WIRE =  1,143E-01 M       GAS FLOW RATE =  2,044E+02 M3/SEC       GAS VELOCITY =  1,158E+00 M/SEC
TEMPERATURE = 601,667 K               PRESSURE =   1,000 ATM                  VISCOSITY =  2,800E-05 KG/M-SEC
ION MOBILITY =  4,846E-04 M2/VOLT-SEC MEAN THERMAL SPEED =  6,311E+02 M/SEC   PART. PATH PARAM. =  1,154E-07 M
DUST WEIGHT =  1,175E+00 KG/SEC       LENGTH INCR. = ,30500000 M              INPUT EFF./INCR. = 14,22


ROVRI     ERAVG       EPLT        AFID        CMCD     MMD       WEIGHT     DUST LAYER   J(PART)      J(ION)   INCR. NO.

1,0002  2,406E+05  1,3748E+05  1,9976E+13   37,3   1,53E-06   1,730E-06   4,875E-05   3,67E-08    3,73E-04     28
1,0002  2,406E+05  1,3748E+05  1,9977E+13   37,3   1,48E-06   1,560E-06   4,394E-05   3,39E-08    3,73E-04     29
1,0002  2,406E+05  1,3748E+05  1,9978E+13   37,3   1,44E-06   1,407E-06   3,964E-05   3,13E-08    3,73E-04     30
1,0001  2,406E+05  1,3748E+05  1,9978E+13   37,3   1,40E-06   1,271E-06   3,580E-05   2,89E-08    3,73E-04     31
1,0001  2,406E+05  1,3748E+05  1,9979E+13   37,3   1,36E-06   1,149E-06   3,237E-05   2,67E-08    3,73E-04     32
1,0001  2,406E+05  1,3748E+05  1,9979E+13   37,3   1,31E-06   1,040E-06   2,929E-05   2,47E-08    3,73E-04     33
1,0001  2,406E+05  1,3748E+05  1,9980E+13   37,3   1,27E-06   9,414E-07   2,652E-05   2,28E-08    3,73E-04     34
1,0000  2,406E+05  1,3748E+05  1,9980E+13   37,3   1,24E-06   8,534E-07   2,404E-05   2,11E-08    3,73E-04     35
1,0000  2,406E+05  1,3748E+05  1,9980E+13   37,3   1,21E-06   7,742E-07   2,181E-05   1,95E-08    3,73E-04     36

EST. EFFICIENCY = 99,60     UNCORRECTED COMPUTED EFFICIENCY = 99,86


INCREMENTAL ANALYSIS OF PRECIPITATOR PERFORMANCE



FULL-SCALE,HOT-SIDE ESP: PLANT B;SCA=390FT2/1000ACFM;J=34,3UA/FT2;EST. PROCED.


CALCULATION IS IN SECTION NO. = 1 AND THE SECTION LENGTH IS =  2,7450 M

COLLECTION AREA =  3,917E+03 M2       APPLIED VOLTAGE =  3,588E+04 VOLTS      TOTAL CURRENT =  1,220E+00 AMPS
WIRE TO PLATE =  1,143E-01 M          CORONA WIRE RADIUS =  1,384E-03 M       CORONA WIRE LENGTH =  1,713E+04 M
CURRENT/M =  7,123E-05 AMP/M          CURRENT DENSITY =  3,115E-04 AMP/M2     DEPOSIT E FIELD =  5,918E+04 VOLT/M
1/2 WIRE TO WIRE =  1,143E-01 M       GAS FLOW RATE =  2,044E+02 M3/SEC       GAS VELOCITY =  1,158E+00 M/SEC
TEMPERATURE = 601,667 K               PRESSURE =   1,000 ATM                  VISCOSITY =  2,800E-05 KG/M-SEC
ION MOBILITY =  4,846E-04 M2/VOLT-SEC MEAN THERMAL SPEED =  6,311E+02 M/SEC   PART. PATH PARAM. =  1,154E-07 M
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DUST WEIGHT =  1.175E+00 KG/SEC        LENGTH INCR. = .30500000 M          INPUT EFF./INCR. = 16.63

ROVRI      ERAVG        EPLT         AFID        CMCD     MMD        WEIGHT     DUST LAYER   J(PART)       J(ION)    INCR. NO.

1.6546   3.139E+05  1.7938E+05  7.7340E+12    31.1   4.21E-05   4.126E-03   1.163E-01   1.33E-06    3.10E-04       1
1.4109   3.139E+05  1.7938E+05  9.0698E+12    31.1   2.05E-05   7.362E-04   2.074E-02   8.35E-07    3.11E-04       2
1.2861   3.139E+05  1.7938E+05  9.9497E+12    31.1   1.08E-05   2.618E-04   7.376E-03   6.58E-07    3.11E-04       3
1.2048   3.139E+05  1.7938E+05  1.0622E+13    31.1   6.37E-06   1.482E-04   4.175E-03   5.56E-07    3.11E-04       4
1.1483   3.139E+05  1.7938E+05  1.1144E+13    31.1   4.27E-06   9.811E-05   2.764E-03   4.81E-07    3.11E-04       5
1.1081   3.139E+05  1.7938E+05  1.1548E+13    31.1   3.35E-06   7.035E-05   1.982E-03   4.21E-07    3.11E-04       6
1.0792   3.139E+05  1.7938E+05  1.1858E+13    31.1   2.97E-06   5.316E-05   1.498E-03   3.71E-07    3.11E-04       7
1.0582   3.139E+05  1.7938E+05  1.2093E+13    31.1   2.68E-06   4.161E-05   1.172E-03   3.28E-07    3.11E-04       8
1.0429   3.139E+05  1.7938E+05  1.2270E+13    31.1   2.48E-06   3.335E-05   9.396E-04   2.92E-07    3.11E-04       9

CALCULATION IS IN SECTION NO. = 2 AND THE SECTION LENGTH IS =  2.7450 M

COLLECTION AREA =  3.917E+03 M2           APPLIED VOLTAGE =  3.395E+04 VOLTS          TOTAL CURRENT =  1.672E+00 AMPS
WIRE TO PLATE =  1.143E-01 M              CORONA WIRE RADIUS =  1.384E-03 M            CORONA WIRE LENGTH =  1.713E+04 M
CURRENT/M =  9.761E-05 AMP/M              CURRENT DENSITY =  4.268E-04 AMP/M2          DEPOSIT E FIELD =  8.110E+04 VOLT/M
1/2 WIRE TO WIRE =  1.143E-01 M           GAS FLOW RATE =  2.044E+02 M3/SEC            GAS VELOCITY =  1.158E+00 M/SEC
TEMPERATURE = 601.667 K                   PRESSURE =   1.000 ATM                       VISCOSITY =  2.800E-05 KG/M-SEC
ION MOBILITY =  4.846E-04 M2/VOLT-SEC     MEAN THERMAL SPEED =  6.311E+02 M/SEC        PART. PATH PARAM. =  1.154E-07 M
DUST WEIGHT =  1.175E+00 KG/SEC           LENGTH INCR. = .30500000 M                   INPUT EFF./INCR. = 16.63

ROVRI      ERAVG        EPLT         AFID        CMCD     MMD        WEIGHT     DUST LAYER   J(PART)       J(ION)    INCR. NO.

1.0219   2.970E+05  1.6973E+05  1.8138E+13    42.7   2.38E-06   2.585E-05   7.282E-04   2.48E-07    4.27E-04      10
1.0163   2.970E+05  1.6973E+05  1.8238E+13    42.7   2.31E-06   2.152E-05   6.064E-04   2.23E-07    4.27E-04      11
1.0122   2.970E+05  1.6973E+05  1.8312E+13    42.7   2.24E-06   1.805E-05   5.086E-04   2.01E-07    4.27E-04      12
1.0091   2.970E+05  1.6973E+05  1.8368E+13    42.7   2.18E-06   1.524E-05   4.294E-04   1.81E-07    4.27E-04      13
1.0068   2.970E+05  1.6973E+05  1.8410E+13    42.7   2.13E-06   1.294E-05   3.645E-04   1.63E-07    4.27E-04      14
1.0051   2.970E+05  1.6973E+05  1.8441E+13    42.7   2.08E-06   1.103E-05   3.109E-04   1.47E-07    4.27E-04      15
1.0038   2.970E+05  1.6973E+05  1.8465E+13    42.7   2.04E-06   9.449E-06   2.662E-04   1.33E-07    4.27E-04      16
1.0029   2.970E+05  1.6973E+05  1.8482E+13    42.7   1.99E-06   8.120E-06   2.288E-04   1.20E-07    4.27E-04      17
1.0021   2.970E+05  1.6973E+05  1.8495E+13    42.7   1.95E-06   6.999E-06   1.972E-04   1.08E-07    4.27E-04      18

CALCULATION IS IN SECTION NO. = 3 AND THE SECTION LENGTH IS =  2.7450 M

COLLECTION AREA =  3.917E+03 M2           APPLIED VOLTAGE =  2.913E+04 VOLTS          TOTAL CURRENT =  1.420E+00 AMPS
WIRE TO PLATE =  1.143E-01 M              CORONA WIRE RADIUS =  1.384E-03 M            CORONA WIRE LENGTH =  1.713E+04 M
CURRENT/M =  8.290E-05 AMP/M              CURRENT DENSITY =  3.625E-04 AMP/M2          DEPOSIT E FIELD =  6.888E+04 VOLT/M
1/2 WIRE TO WIRE =  1.143E-01 M           GAS FLOW RATE =  2.044E+02 M3/SEC            GAS VELOCITY =  1.158E+00 M/SEC
TEMPERATURE = 601.667 K                   PRESSURE =   1.000 ATM                       VISCOSITY =  2.800E-05 KG/M-SEC
ION MOBILITY =  4.846E-04 M2/VOLT-SEC     MEAN THERMAL SPEED =  6.311E+02 M/SEC        PART. PATH PARAM. =  1.154E-07 M
DUST WEIGHT =  1.175E+00 KG/SEC           LENGTH INCR. = .30500000 M                   INPUT EFF./INCR. = 16.63

ROVRI      ERAVG        EPLT         AFID        CMCD     MMD        WEIGHT     DUST LAYER   J(PART)       J(ION)    INCR. NO.

1.0016   2.549E+05  1.4563E+05  1.8316E+13    36.3   1.91E-06   5.243E-06   1.477E-04   8.46E-08    3.62E-04      19
1.0012   2.549E+05  1.4563E+05  1.8323E+13    36.3   1.87E-06   4.635E-06   1.306E-04   7.76E-08    3.62E-04      20
1.0009   2.549E+05  1.4563E+05  1.8329E+13    36.3   1.84E-06   4.104E-06   1.156E-04   7.11E-08    3.62E-04      21
1.0007   2.549E+05  1.4563E+05  1.8333E+13    36.3   1.80E-06   3.641E-06   1.026E-04   6.52E-08    3.62E-04      22
1.0006   2.549E+05  1.4563E+05  1.8336E+13    36.3   1.77E-06   3.235E-06   9.114E-05   5.99E-08    3.62E-04      23
1.0004   2.549E+05  1.4563E+05  1.8338E+13    36.3   1.72E-06   2.878E-06   8.109E-05   5.48E-08    3.62E-04      24
1.0003   2.549E+05  1.4563E+05  1.8340E+13    36.3   1.67E-06   2.565E-06   7.226E-05   5.03E-08    3.62E-04      25
1.0002   2.549E+05  1.4563E+05  1.8341E+13    36.3   1.62E-06   2.288E-06   6.447E-05   4.61E-08    3.62E-04      26
1.0002   2.549E+05  1.4563E+05  1.8343E+13    36.3   1.57E-06   2.045E-06   5.760E-05   4.23E-08    3.62E-04      27
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CALCULATION IS IN SECTION NO. = 4 AND THE SECTION LENGTH IS =  2.7450 M

COLLECTION AREA =  3.917E+03 M2        APPLIED VOLTAGE =  2.750E+04 VOLTS         TOTAL CURRENT =  1.460E+00 AMPS
WIRE TO PLATE =  1.143E-01 M           CORONA WIRE RADIUS =  1.384E-03 M          CORONA WIRE LENGTH =  1.713E+04 M
CURRENT/M =  8.524E-05 AMP/M           CURRENT DENSITY =  3.727E-04 AMP/M2        DEPOSIT E FIELD =  7,082E+04 VOLT/M
1/2 WIRE TO WIRE =  1.143E-01 M        GAS FLOW RATE =  2.044E+02 M3/SEC          GAS VELOCITY =  1.158E+00 M/SEC
TEMPERATURE = 601.607 K                PRESSURE =   1.000 ATM                     VISCOSITY =  2.800E-05 KG/M-SEC
ION MOBILITY =  4.846E-04 M2/VOLT-SEC  MEAN THERMAL SPEED =  6.311E+02 M/SEC       PART. PATH PARAM, =  1,154E-07 M
DUST WEIGHT =  1.175E+00 KG/SEC        LENGTH INCR, = .30500000 M                 INPUT EFF,/INCR, = 16,63

ROVRI     ERAVG       EPLT        AFID        CMCD     MMD        WEIGHT      DUST LAYER  J(PART)     J(ION)     INCR, NO,

1,0001   2,406E+05  1.3748E+05  1,9978E+13   37,3   1.52E-06   1.732E-06   4.880E-05   3.67E-08    3,73E-04      28
1,0001   2,406E+05  1.3748E+05  1,9979E+13   37,3   1.48E-06   1.561E-06   4.398E-05   3.39E-08    3,73E-04      29
1,0001   2,406E+05  1.3748E+05  1,9979E+13   37,3   1.44E-06   1.408E-06   3,967E-05   3,13E-08    3,73E-04      30
1,0001   2,406E+05  1.3748E+05  1,9980E+13   37,3   1.39E-06   1.272E-06   3,582E-05   2,89E-08    3,73E-04      31
1,0000   2,406E+05  1.3748E+05  1,9980E+13   37,3   1.35E-06   1.149E-06   3.238E-05   2,67E-08    3,73E-04      32
1,0000   2,406E+05  1.3748E+05  1,9980E+13   37,3   1.31E-06   1,040E-06   2.930E-05   2,47E-08    3,73E-04      33
1,0000   2,406E+05  1.3748E+05  1,9980E+13   37,3   1.27E-06   9,418E-07   2.653E-05   2,28E-08    3,73E-04      34
1,0000   2,406E+05  1.3748E+05  1,9980E+13   37,3   1,24E-06   8,536E-07   2.405E-05   2,11E-08    3,73E-04      35
1,0000   2.406E+05  1.3748E+05  1,9981E+13   37,3   1,21E-06   7,744E-07   2,182E-05   1,95E-08    3,73E-04      36

EST EFFICIENCY = 99,86      COMPUTED EFFICIENCY = 99,86      CONVERGES
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CHARGING RATES FOR PARTICLE SIZES FROM SUBROUTINE CHARGN OR CHGSUM

SUM OF CLASSICAL FIELD AND DIFFUSIONAL CHARGES USED FOR PARTICLE

INCREMENT NO.     Q/QSATF FOR INDICATED PARTICLE SIZES

                                                                                0.3500E-05  0.4500E-05
     0.3000E-06  0.5500E-06  0.8500E-06  0.1250E-05  0.1750E-05                 1.2494      1.2156
  1  1.3047      1.3047      1.3047      1.3047      1.3047      1.             1.3931      1.3534
  2  2.2101      1.9978      1.6082      1.6584      1.5506      1.4597         1.4518      1.4086
  3  2.3817      2.1292      1.9128      1.7447      1.6250      1.5248         1.4850      1.4392
  4  2.4967      2.2149      1.9792      1.7978      1.6694      1.5625         1.5068      1.4591
  5  2.5827      2.2778      2.0270      1.8352      1.7001      1.5879         1.5227      1.4733
  6  2.6511      2.3273      2.0640      1.8637      1.7231      1.6066         1.5348      1.4840
  7  2.7077      2.3679      2.0941      1.8866      1.7413      1.6212         1.5445      1.4926
  8  2.7558      2.4021      2.1193      1.9056      1.7563      1.6331         1.5526      1.4996
  9  2.7976      2.4317      2.1409      1.9218      1.7690      1.6430         1.5586      1.4996
 10  2.8463      2.4650      2.1641      1.9381      1.7808      1.6513         1.5586      1.4996
 11  2.8881      2.4935      2.1839      1.9521      1.7909      1.6585         1.5586      1.4996
 12  2.9246      2.5184      2.2013      1.9643      1.7998      1.6585         1.5586      1.4996
 13  2.9570      2.5406      2.2167      1.9751      1.7998      1.6585         1.5586      1.4996
 14  2.9862      2.5605      2.2306      1.9849      1.7998      1.6585         1.5586      1.4996
 15  3.0127      2.5786      2.2432      1.9849      1.7998      1.6585         1.5586      1.4996
 16  3.0370      2.5951      2.2547      1.9849      1.7998      1.6585         1.5586      1.4996
 17  3.0593      2.6104      2.2654      1.9849      1.7998      1.6585         1.5586      1.4996
 18  3.0801      2.6245      2.2654      1.9849      1.7998      1.6585         1.5586      1.4996
 19  3.0992      2.6376      2.2654      1.9849      1.7998      1.6585         1.5586      1.4996
 20  3.1172      2.6376      2.2654      1.9849      1.7998      1.6585         1.5586      1.4996
 21  3.1341      2.6376      2.2654      1.9849      1.7998      1.6585         1.5586      1.4996
 22  3.1500      2.6376      2.2654      1.9849      1.7998      1.6585         1.5586      1.4996
 23  3.1651      2.6376      2.2654      1.9849      1.7998      1.6585         1.5586      1.4996
 24  3.1651      2.6376      2.2654      1.9849      1.7998      1.6585         1.5586      1.4996
 25  3.1651      2.6376      2.2654      1.9849      1.7998      1.6585         1.5586      1.4996
 26  3.1651      2.6376      2.2654      1.9849      1.7998      1.6585         1.5586      1.4996
 27  3.1651      2.6376      2.2654      1.9849      1.7998      1.6585         1.5586      1.4996
 28  3.1651      2.6376      2.2654      1.9849      1.7998      1.6585         1.5586      1.4996
 29  3.1651      2.6376      2.2654      1.9849      1.7998      1.6585         1.5586      1.4996
 30  3.1651      2.6376      2.2654      1.9849      1.7998      1.6585         1.5586      1.4996
 31  3.1651      2.6376      2.2654      1.9849      1.7998      1.6585         1.5586      1.4996
 32  3.1651      2.6376      2.2654      1.9849      1.7998      1.6585         1.5586      1.4996
 33  3.1651      2.6376      2.2654      1.9849      1.7998      1.6585         1.5586      1.4996
 34  3.1651      2.6376      2.2654      1.9849      1.7998      1.6585         1.5586      1.4996
 35  3.1651      2.6376      2.2654      1.9849      1.7998      1.6585         1.5586      1.4996
 36  3.1651      2.6376      2.2654      1.9849      1.7998      1.6585

     0.6000E-05  0.8500E-05  0.1250E-04  0.2000E-04  0.2750E-04  0.6500E-04
  1  1.1842      1.1544      1.1299      1.1088      1.0985      1.0813
  2  1.3168      1.2824      1.2543      1.2304      1.2188      1.1996
  3  1.3688      1.3317      1.3015      1.2758      1.2635      1.2431
  4  1.3972      1.3581      1.3263      1.2994      1.2865      1.2653
  5  1.4153      1.3746      1.3417      1.3138      1.3005      1.2766
  6  1.4280      1.3861      1.3522      1.3236      1.3099      1.2874
  7  1.4376      1.3946      1.3598      1.3305      1.3166      1.2936
  8  1.4451      1.4012      1.3657      1.3358      1.3216      1.2936
  9  1.4512      1.4012      1.3657      1.3358      1.3216      1.2936
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10  1.4512      1.4012      1.3657      1.3358      1.3216      1.2936
11  1.4512      1.4012      1.3657      1.3358      1.3216      1.2936
12  1.4512      1.4012      1.3657      1.3358      1.3216      1.2936
13  1.4512      1.4012      1.3657      1.3358      1.3216      1.2936
14  1.4512      1.4012      1.3657      1.3358      1.3216      1.2936
15  1.4512      1.4012      1.3657      1.3358      1.3216      1.2936
16  1.4512      1.4012      1.3657      1.3358      1.3216      1.2936
17  1.4512      1.4012      1.3657      1.3358      1.3216      1.2936
18  1.4512      1.4012      1.3657      1.3358      1.3216      1.2936
19  1.4512      1.4012      1.3657      1.3358      1.3216      1.2936
20  1.4512      1.4012      1.3657      1.3358      1.3216      1.2936
21  1.4512      1.4012      1.3657      1.3358      1.3216      1.2936
22  1.4512      1.4012      1.3657      1.3358      1.3216      1.2936
23  1.4512      1.4012      1.3657      1.3358      1.3216      1.2936
24  1.4512      1.4012      1.3657      1.3358      1.3216      1.2936
25  1.4512      1.4012      1.3657      1.3358      1.3216      1.2936
26  1.4512      1.4012      1.3657      1.3358      1.3216      1.2936
27  1.4512      1.4012      1.3657      1.3358      1.3216      1.2936
28  1.4512      1.4012      1.3657      1.3358      1.3216      1.2936
29  1.4512      1.4012      1.3657      1.3358      1.3216      1.2936
30  1.4512      1.4012      1.3657      1.3358      1.3216      1.2936
31  1.4512      1.4012      1.3657      1.3358      1.3216      1.2936
32  1.4512      1.4012      1.3657      1.3358      1.3216      1.2936
33  1.4512      1.4012      1.3657      1.3358      1.3216      1.2936
34  1.4512      1.4012      1.3657      1.3358      1.3216      1.2936
35  1.4512      1.4012      1.3657      1.3358      1.3216      1.2936
36  1.4512      1.4012      1.3657      1.3358      1.3216      1.2936
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 CHARGE ACCUMULATED ON PARTICLE SIZES IN EACH INCREMENT

INCREMENT        CHARGE FOR INDICATED PARTICLE SIZES

       0.3000E-06    0.5500E-06    0.8500E-06    0.1250E-05    0.1750E-05    0.2500E-05    0.3500E-05    0.4500E-05
  1   0.39845E-17   0.10717E-16   0.23786E-16   0.49780E-16   0.96099E-16   0.19443E-15   0.36332E-15   0.58325E-15
  2   0.67495E-17   0.16409E-16   0.32963E-16   0.63272E-16   0.11421E-15   0.21752E-15   0.40511E-15   0.64937E-15
  3   0.72736E-17   0.17489E-16   0.34872E-16   0.66567E-16   0.11969E-15   0.22721E-15   0.42219E-15   0.67585E-15
  4   0.76247E-17   0.18192E-16   0.36081E-16   0.68591E-16   0.12296E-15   0.23283E-15   0.43183E-15   0.69053E-15
  5   0.78873E-17   0.18709E-16   0.36952E-16   0.70019E-16   0.12522E-15   0.23663E-15   0.43819E-15   0.70006E-15
  6   0.80963E-17   0.19116E-16   0.37627E-16   0.71109E-16   0.12691E-15   0.23942E-15   0.44279E-15   0.70687E-15
  7   0.82692E-17   0.19449E-16   0.38176E-16   0.71982E-16   0.12826E-15   0.24159E-15   0.44632E-15   0.71203E-15
  8   0.84161E-17   0.19730E-16   0.38635E-16   0.72707E-16   0.12936E-15   0.24336E-15   0.44915E-15   0.71613E-15
  9   0.85436E-17   0.19973E-16   0.39029E-16   0.73324E-16   0.13029E-15   0.24483E-15   0.45149E-15   0.71948E-15
 10   0.86923E-17   0.20246E-16   0.39451E-16   0.73946E-16   0.13116E-15   0.24608E-15   0.45323E-15   0.71948E-15
 11   0.88199E-17   0.20481E-16   0.39814E-16   0.74479E-16   0.13191E-15   0.24714E-15   0.45323E-15   0.71948E-15
 12   0.89315E-17   0.20685E-16   0.40131E-16   0.74945E-16   0.13256E-15   0.24714E-15   0.45323E-15   0.71948E-15
 13   0.90306E-17   0.20867E-16   0.40412E-16   0.75359E-16   0.13256E-15   0.24714E-15   0.45323E-15   0.71948E-15
 14   0.91197E-17   0.21031E-16   0.40665E-16   0.75731E-16   0.13256E-15   0.24714E-15   0.45323E-15   0.71948E-15
 15   0.92006E-17   0.21179E-16   0.40894E-16   0.75731E-16   0.13256E-15   0.24714E-15   0.45323E-15   0.71948E-15
 16   0.92747E-17   0.21315E-16   0.41105E-16   0.75731E-16   0.13256E-15   0.24714E-15   0.45323E-15   0.71948E-15
 17   0.93430E-17   0.21441E-16   0.41298E-16   0.75731E-16   0.13256E-15   0.24714E-15   0.45323E-15   0.71948E-15
 18   0.94063E-17   0.21557E-16   0.41298E-16   0.75731E-16   0.13256E-15   0.24714E-15   0.45323E-15   0.71948E-15
 19   0.94648E-17   0.21664E-16   0.41298E-16   0.75731E-16   0.13256E-15   0.24714E-15   0.45323E-15   0.71948E-15
 20   0.95196E-17   0.21664E-16   0.41298E-16   0.75731E-16   0.13256E-15   0.24714E-15   0.45323E-15   0.71948E-15
 21   0.95712E-17   0.21664E-16   0.41298E-16   0.75731E-16   0.13256E-15   0.24714E-15   0.45323E-15   0.71948E-15
 22   0.96198E-17   0.21664E-16   0.41298E-16   0.75731E-16   0.13256E-15   0.24714E-15   0.45323E-15   0.71948E-15
 23   0.96659E-17   0.21664E-16   0.41298E-16   0.75731E-16   0.13256E-15   0.24714E-15   0.45323E-15   0.71948E-15
 24   0.96659E-17   0.21664E-16   0.41298E-16   0.75731E-16   0.13256E-15   0.24714E-15   0.45323E-15   0.71948E-15
 25   0.96659E-17   0.21664E-16   0.41298E-16   0.75731E-16   0.13256E-15   0.24714E-15   0.45323E-15   0.71948E-15
 26   0.96659E-17   0.21664E-16   0.41298E-16   0.75731E-16   0.13256E-15   0.24714E-15   0.45323E-15   0.71948E-15
 27   0.96659E-17   0.21664E-16   0.41298E-16   0.75731E-16   0.13256E-15   0.24714E-15   0.45323E-15   0.71948E-15
 28   0.96659E-17   0.21664E-16   0.41298E-16   0.75731E-16   0.13256E-15   0.24714E-15   0.45323E-15   0.71948E-15
 29   0.96659E-17   0.21664E-16   0.41298E-16   0.75731E-16   0.13256E-15   0.24714E-15   0.45323E-15   0.71948E-15
 30   0.96659E-17   0.21664E-16   0.41298E-16   0.75731E-16   0.13256E-15   0.24714E-15   0.45323E-15   0.71948E-15
 31   0.96659E-17   0.21664E-16   0.41298E-16   0.75731E-16   0.13256E-15   0.24714E-15   0.45323E-15   0.71948E-15
 32   0.96659E-17   0.21664E-16   0.41298E-16   0.75731E-16   0.13256E-15   0.24714E-15   0.45323E-15   0.71948E-15
 33   0.96659E-17   0.21664E-16   0.41298E-16   0.75731E-16   0.13256E-15   0.24714E-15   0.45323E-15   0.71948E-15
 34   0.96659E-17   0.21664E-16   0.41298E-16   0.75731E-16   0.13256E-15   0.24714E-15   0.45323E-15   0.71948E-15
 35   0.96659E-17   0.21664E-16   0.41298E-16   0.75731E-16   0.13256E-15   0.24714E-15   0.45323E-15   0.71948E-15
 36   0.96659E-17   0.21664E-16   0.41298E-16   0.75731E-16   0.13256E-15   0.24714E-15   0.45323E-15   0.71948E-15

       0.6000E-05    0.8500E-05    0.1250E-04    0.2000E-04    0.2750E-04    0.6500E-04
  1   0.10087E-14   0.19717E-14   0.41711E-14   0.10475E-13   0.19618E-13   0.10787E-12
  2   0.11216E-14   0.21903E-14   0.46305E-14   0.11624E-13   0.21766E-13   0.11967E-12
  3   0.11660E-14   0.22745E-14   0.48045E-14   0.12053E-13   0.22564E-13   0.12401E-12
  4   0.11901E-14   0.23195E-14   0.48961E-14   0.12276E-13   0.22976E-13   0.12622E-12
  5   0.12056E-14   0.23478E-14   0.49529E-14   0.12412E-13   0.23225E-13   0.12755E-12
  6   0.12164E-14   0.23674E-14   0.49916E-14   0.12504E-13   0.23392E-13   0.12843E-12
  7   0.12246E-14   0.23819E-14   0.50199E-14   0.12570E-13   0.23512E-13   0.12905E-12
  8   0.12309E-14   0.23931E-14   0.50415E-14   0.12620E-13   0.23602E-13   0.12905E-12
  9   0.12361E-14   0.23931E-14   0.50415E-14   0.12620E-13   0.23602E-13   0.12905E-12
 10   0.12361E-14   0.23931E-14   0.50415E-14   0.12620E-13   0.23602E-13   0.12905E-12
 11   0.12361E-14   0.23931E-14   0.50415E-14   0.12620E-13   0.23602E-13   0.12905E-12
 12   0.12361E-14   0.23931E-14   0.50415E-14   0.12620E-13   0.23602E-13   0.12905E-12
 13   0.12361E-14   0.23931E-14   0.50415E-14   0.12620E-13   0.23602E-13   0.12905E-12
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14   0,12361E-14   0,23931E-14   0,50415E-14   0,12620E-13   0,23602E-13   0,12905E-12
15   0,12361E-14   0,23931E-14   0,50415E-14   0,12620E-13   0,23602E-13   0,12905E-12
16   0,12361E-14   0,23931E-14   0,50415E-14   0,12620E-13   0,23602E-13   0,12905E-12
17   0,12361E-14   0,23931E-14   0,50415E-14   0,12620E-13   0,23602E-13   0,12905E-12
18   0,12361E-14   0,23931E-14   0,50415E-14   0,12620E-13   0,23602E-13   0,12905E-12
19   0,12361E-14   0,23931E-14   0,50415E-14   0,12620E-13   0,23602E-13   0,12905E-12
20   0,12361E-14   0,23931E-14   0,50415E-14   0,12620E-13   0,23602E-13   0,12905E-12
21   0,12361E-14   0,23931E-14   0,50415E-14   0,12620E-13   0,23602E-13   0,12905E-12
22   0,12361E-14   0,23931E-14   0,50415E-14   0,12620E-13   0,23602E-13   0,12905E-12
23   0,12361E-14   0,23931E-14   0,50415E-14   0,12620E-13   0,23602E-13   0,12905E-12
24   0,12361E-14   0,23931E-14   0,50415E-14   0,12620E-13   0,23602E-13   0,12905E-12
25   0,12361E-14   0,23931E-14   0,50415E-14   0,12620E-13   0,23602E-13   0,12905E-12
26   0,12361E-14   0,23931E-14   0,50415E-14   0,12620E-13   0,23602E-13   0,12905E-12
27   0,12361E-14   0,23931E-14   0,50415E-14   0,12620E-13   0,23602E-13   0,12905E-12
28   0,12361E-14   0,23931E-14   0,50415E-14   0,12620E-13   0,23602E-13   0,12905E-12
29   0,12361E-14   0,23931E-14   0,50415E-14   0,12620E-13   0,23602E-13   0,12905E-12
30   0,12361E-14   0,23931E-14   0,50415E-14   0,12620E-13   0,23602E-13   0,12905E-12
31   0,12361E-14   0,23931E-14   0,50415E-14   0,12620E-13   0,23602E-13   0,12905E-12
32   0,12361E-14   0,23931E-14   0,50415E-14   0,12620E-13   0,23602E-13   0,12905E-12
33   0,12361E-14   0,23931E-14   0,50415E-14   0,12620E-13   0,23602E-13   0,12905E-12
34   0,12361E-14   0,23931E-14   0,50415E-14   0,12620E-13   0,23602E-13   0,12905E-12
35   0,12361E-14   0,23931E-14   0,50415E-14   0,12620E-13   0,23602E-13   0,12905E-12
36   0,12361E-14   0,23931E-14   0,50415E-14   0,12620E-13   0,23602E-13   0,12905E-12
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PARTICLE SIZE RANGE STATISTICS


CORRECTIONS FOR NONIDEALITIES USING SET NO,  1 OF CORRECTION PARAMETERS

  SIZE      CCF  INLET % OUTLET % COR, OUTLET % NO-RAP EFF, NO-RAP W  NO-RAP P  COR, EFF.   COR, W     COR, P
3,000E-07  2,040  0,148   1,2983         0,4215      99,7973     8,088    0,2027   99,7248    7,689      0,2752
5,500E-07  1,540  0,426  10,7592         3.1792      99,4172     6,711    0,5628   99,2799    6,435      0,7201
8,500E-07  1,343  0,435  12,2799         4,1357      99,3482     6,565    0,6518   99,0820    6,118      0,9160
1,250E-06  1,232  0,713  15,7100         6,7946      99,4915     6,889    0,5085   99,0803    6,116      0,9197
1,750E-06  1,166  1,027  15,2122         7,4556      99,6579     7,406    0,3421   99,2987    6,469      0,7013
2,500E-06  1,116  3,776  29,6402        15,4224      99,8187     8,234    0,1813   99,6056    7,220      0,3944
3,500E-06  1,083  2,958  10,9425        10,5676      99,9146     9,216    0,0854   99,6550    7,395      0,3450
4,500E-06  1,064  1,653   3,2258         7,7854      99,9549    10,050    0,0451   99,5452    7,034      0,4548
6,000E-06  1,048  1,914   0,4666        11,2072      99,9944    12,763    0,0056   99,4346    6,750      0,5654
8,500E-06  1,034  2,575   0,0993        11,0389      99,9991    15,168    0,0009   99,5861    7,157      0,4139
1,250E-05  1,023  4,559   0,0198         9,8985      99,9999    21,499    0,0001   99,7903    8,044      0,2097
2,000E-05  1,015 10,788   0,0468         7,5397      99,9999    33,350    0,0001   99,9325    9,523      0,0675
2,750E-05  1,011  4,524   0,0196         1,5366      99,9999    45,184    0,0001   99,9672   10,464      0,0328
6,500E-05  1,004 64,503   0,2797         3,0170      99,9999   103,896    0,0001   99,9955   13,050      0,0045

EFFICIENCIES FOR CONVERGENCE CHECK:  STATED OR PREVIOUS CALCULATION =  99,857   FINAL CALCULATION =  99,857


   ADJUSTED NO-RAP EFF, =  99,9769
   MMD OF INLET SIZE DISTRIBUTION =  5,172E+01
   SIGMAP OF INLET SIZE DISTRIBUTION =  5,542E+00
   LOG-NORMAL GOODNESS OF FIT =  0,992
   MMD OF EFFLUENT UNDER NO-RAP CONDITIONS =  1,580E+00
   SIGMAP OF EFFLUENT UNDER NO-RAP CONDITIONS =  1,851E+00
   LOG-NORMAL GOODNESS OF FIT =  0,992
   PRECIPITATION RATE PARAMETER UNDER NO-RAP CONDITIONS = 10,922


   SIGMAG=    0,000  WITH  0,000 SNEAKAGE OVER    4,000  STAGES
   NTEMP = 2
   RMMD =  6,00
   RSIGMA = 2,50
   CORR, EFF, =  99,9034
   CORRECTED MMD OF EFFLUENT =  4,467E+00
   CORRECTED SIGMAP OF EFFLUENT =  2,713E+00
   LOG-NORMAL GOODNESS OF FIT =  0,998
   CORRECTED PRECIPITATION RATE PARAMETER =    9,06
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[illegible] MIGRATION VELOCITIES AND EFFICIENCIES, AND DISCRETE OUTLET MASS LOADINGS

[illegible]	[illegible] EFFICIENCY (%)	NO-RAP DM/DLOGD (MG/DSCM)	RAPPING PUFF DM/DLOGD (MG/DSCM)	NO-RAP+RAP PUFF DM/DLOGD (MG/DSCM)	RAPPING PUFF DISTRIBUTION (%)	PARTICLE DIAM. (M)
[illegible]	[illegible]	1.264E-01	4.523E-02	1.716E-01	1.450E-01	3.000E-07
[illegible]	[illegible]	1.297E+00	3.056E-01	1.603E+00	7.960E-01	5.500E-07
[illegible]	[illegible]	2.323E+00	9.669E-01	3.272E+00	1.574E+00	8.500E-07
[illegible]	[illegible]	2.615E+00	2.114E+00	4.729E+00	3.980E+00	1.250E-06
[illegible]	[illegible]	3.566E+00	3.745E+00	7.314E+00	5.012E+00	1.750E-06
[illegible]	[illegible]	4.932E+00	5.801E+00	1.073E+01	1.094E+01	2.500E-06
[illegible]	[illegible]	2.567E+00	7.799E+00	1.037E+01	1.044E+01	3.500E-06
[illegible]	[illegible]	9.753E-01	8.871E+00	9.846E+00	9.208E+00	4.500E-06
[illegible]	[illegible]	5.259E-02	9.316E+00	9.399E+00	1.457E+01	6.000E-06
[illegible]	1.000E+02	1.483E-02	6.715E+00	6.734E+00	1.446E+01	8.500E-06
[illegible]	1.000E+02	2.794E-03	6.889E+00	6.892E+00	1.299E+01	1.250E-05
[illegible]	1.000E+02	6.160E-03	4.165E+00	4.171E+00	9.898E+00	2.000E-05
[illegible]	1.000E+02	7.282E-03	2.370E+00	2.380E+00	2.017E+00	2.750E-05
[illegible]	1.000E+02	1.566E-02	7.072E-01	7.229E-01	3.961E+00	6.500E-05

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                              E.P.A. ESP MODEL
                        I.E.R.L.-R.T.P. AND SO.R.I.

                        SUMMARY TABLE OF ESP OPERATING
                          PARAMETERS AND PERFORMANCE


                              DATA SET NUMBER   1

                        NON-IDEAL CONDITION SET NUMBER  1

ESP PERFORMANCE:     EFFICIENCY =  99.[illegible] %     SCA =  7.667E+01 M**2/(M**3/SEC)
                                                            ( 389. FT**2/1000 ACFM)

ELECTRICAL CONDITIONS:     AVG. APPLIED VOLTAGE =  3.101E+04 V
                           AVG. CURRENT DENSITY =   30.84 NA/CM**2
                           RESISTIVITY =  1.900E+10 OHM-CM

SIZE DISTRIBUTIONS:     INLET MMD =  5.172E+01 UM     INLET SIGMAP =  3.342E+00
                        OUTLET MMD =  6.667E+00 UM     OUTLET SIGMAP =  2.713E+00

NONIDEAL PARAMETERS:     GAS SNEAKAGE FRACTION =  .00 /SECTION     GAS VELOCITY SIGMAG =  .00
                         RAPPING MMD =  6.000E+00 UM     RAPPING SIGMAP =  2.500E+00
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[illegible]

[illegible]

[illegible]                                                    COR. EFF.   CUR. W      COR. P
[illegible]                                       99.1022    6.271  0.8978   98.9481   5.961      1.0519
[illegible]                                       98.1909    5.233  1.8091   97.7457   4.946      2.2543
[illegible]                                       97.9515    5.071  2.0485   97.0886   4.813      2.9114
[illegible]                                       98.1834    5.220  1.8166   96.8505   4.510      3.1495
[illegible]                                       98.5143    5.161  1.4857   97.3403   4.731      2.6597
[illegible]                                       98.8733    5.851  1.1267   98.1824   5.227      1.8176
[illegible]                                       99.1209    6.175  0.8791   98.2796   5.299      1.7204
[illegible]                                       99.2117    6.317  0.7883   97.8836   5.029      2.1164
[illegible]                                       99.6026    7.210  0.3974   97.7882   4.971      2.2118
[illegible]                                       99.5541    7.040  0.4459   98.2113   5.248      1.7887
[illegible]                                       99.9383    9.639  0.0617   99.2587   6.397      0.7413
[illegible]                                       99.9989   16.952  0.0011   99.7802   7.983      0.2198
[illegible]                                       99.9999   45.166  0.0001   99.8937   8.930      0.1063
[illegible]                                       99.9999  103.896  0.0001   99.9854  11.516      0.0146

[illegible] CALCULATION =  99.837   FINAL CALCULATION =  99.837

   [illegible]
   [illegible]
   [illegible]
   [illegible]
   [illegible]
   [illegible]
   [illegible]
   [illegible]

   [illegible]
   [illegible]
   [illegible]
   [illegible]
   [illegible]
   [illegible]
   [illegible]
   [illegible]
   [illegible] =    7.26
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[illegible] MASS LOADINGS

[illegible]	[illegible]	[illegible]	MAPPING PUFF DM/DLOGD (MG/DSCM)	NO-MAP+MAP PUFF DM/DLOGD (MG/DSCM)	MAPPING PUFF DISTRIBUTION (%)	PARTICLE DIAM, (M)
[illegible]	[illegible]	[illegible]	[illegible]	6.559E-01	1.458E-01	3.000E-07
[illegible]	[illegible]	[illegible]	[illegible]	5.019E+00	7.960E-01	5.500E-07
[illegible]	[illegible]	[illegible]	[illegible]	1.030E+01	1.574E+00	8.500E-07
[illegible]	[illegible]	[illegible]	[illegible]	1.019E+01	3.988E+00	1.250E-06
[illegible]	[illegible]	[illegible]	[illegible]	2.774E+01	5.012E+00	1.750E-06
[illegible]	[illegible]	[illegible]	[illegible]	4.967E+01	1.094E+01	2.500E-06
[illegible]	[illegible]	[illegible]	[illegible]	5.170E+01	1.044E+01	3.500E-06
[illegible]	[illegible]	[illegible]	[illegible]	4.502E+01	9.408E+00	4.500E-06
[illegible]	[illegible]	[illegible]	[illegible]	3.677E+01	1.457E+01	6.000E-06
[illegible]	[illegible]	[illegible]	[illegible]	3.776E+01	1.446E+01	8.500E-06
[illegible]	[illegible]	[illegible]	[illegible]	2.438E+01	1.499E+01	1.250E-05
[illegible]	[illegible]	[illegible]	[illegible]	1.357E+01	9.898E+00	2.000E-05
[illegible]	[illegible]	[illegible]	[illegible]	7.717E+00	2.017E+00	2.750E-05
[illegible]	[illegible]	[illegible]	[illegible]	2.308E+00	3.961E+00	6.500E-05

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                         E.P.A. ESP MODEL
                  I.E.R.L.--R.T.P. AND SO.R.I.

                  SUMMARY TABLE OF ESP OPERATING
                    PARAMETERS AND PERFORMANCE


                        DATA SET NUMBER   1

                  NON-IDEAL CONDITION SET NUMBER  2

ESP PERFORMANCE     EFFICIENCY =  99.6117 %     SCA =  7.667E+01 M**2/(M**3/SEC)
                                                      ( 389. FT**2/1000 ACFM)

OPERATING CONDITIONS     AVG. APPLIED VOLTAGE =  3.161E+04 V
                         AVG. CURRENT DENSITY =   36.84 NA/CM**2
                         RESISTIVITY =  1.900E+10 OHM-CM

SIZE DISTRIBUTIONS     INLET MMD =  [illegible] UM     INLET SIGMAP =  5.542E+00
                       OUTLET MMD =  [illegible] UM     OUTLET SIGMAP =  2.567E+00

NONIDEAL PARAMETERS     GAS SNEAKAGE FRACTION =  .10 /SECTION     GAS VELOCITY SIGMAG =  .25
                        RAPPING MMD =  6.000E+00 UM     RAPPING SIGMAP =  2.500E+00
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